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# Post Office telecommunications journal

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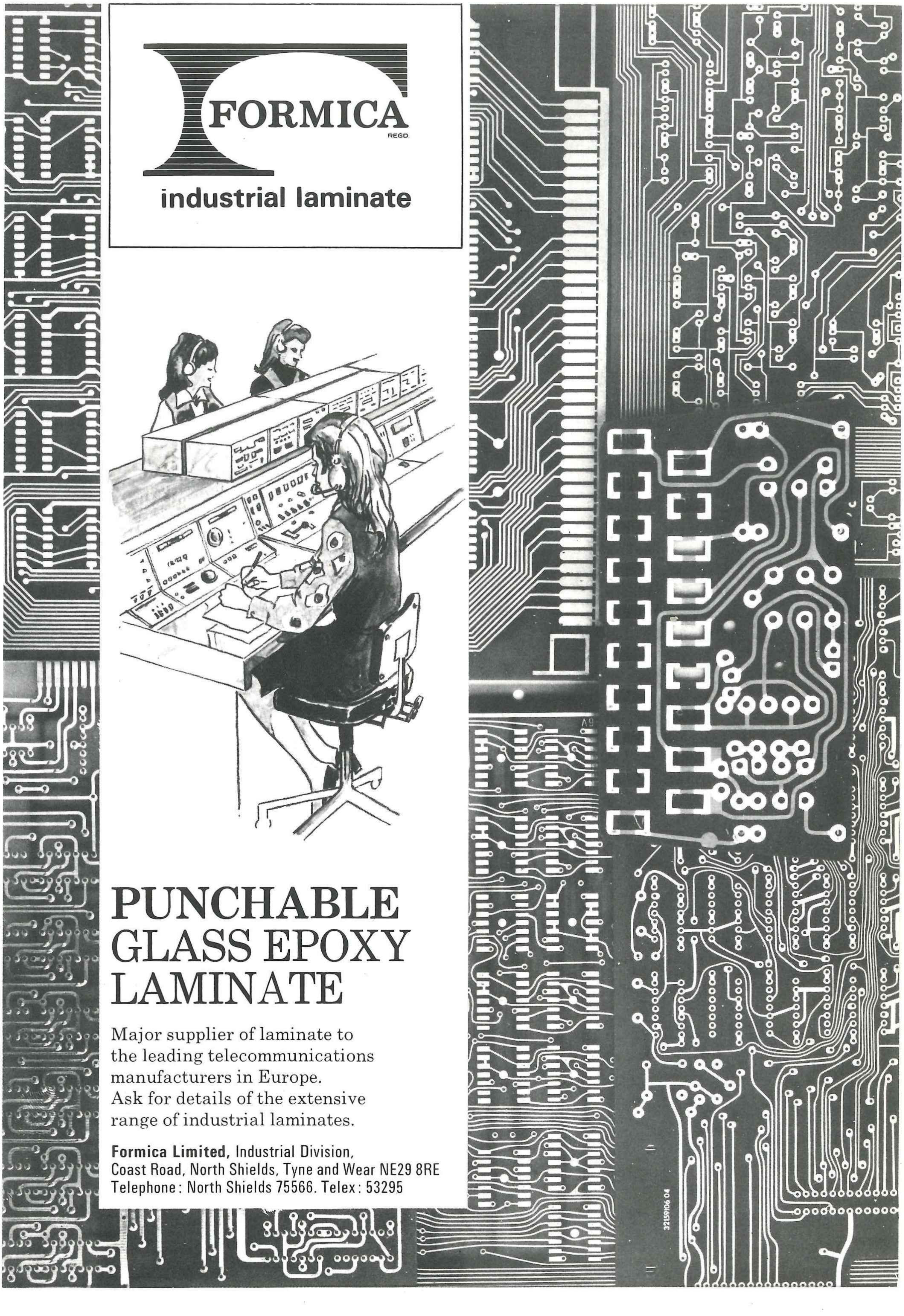
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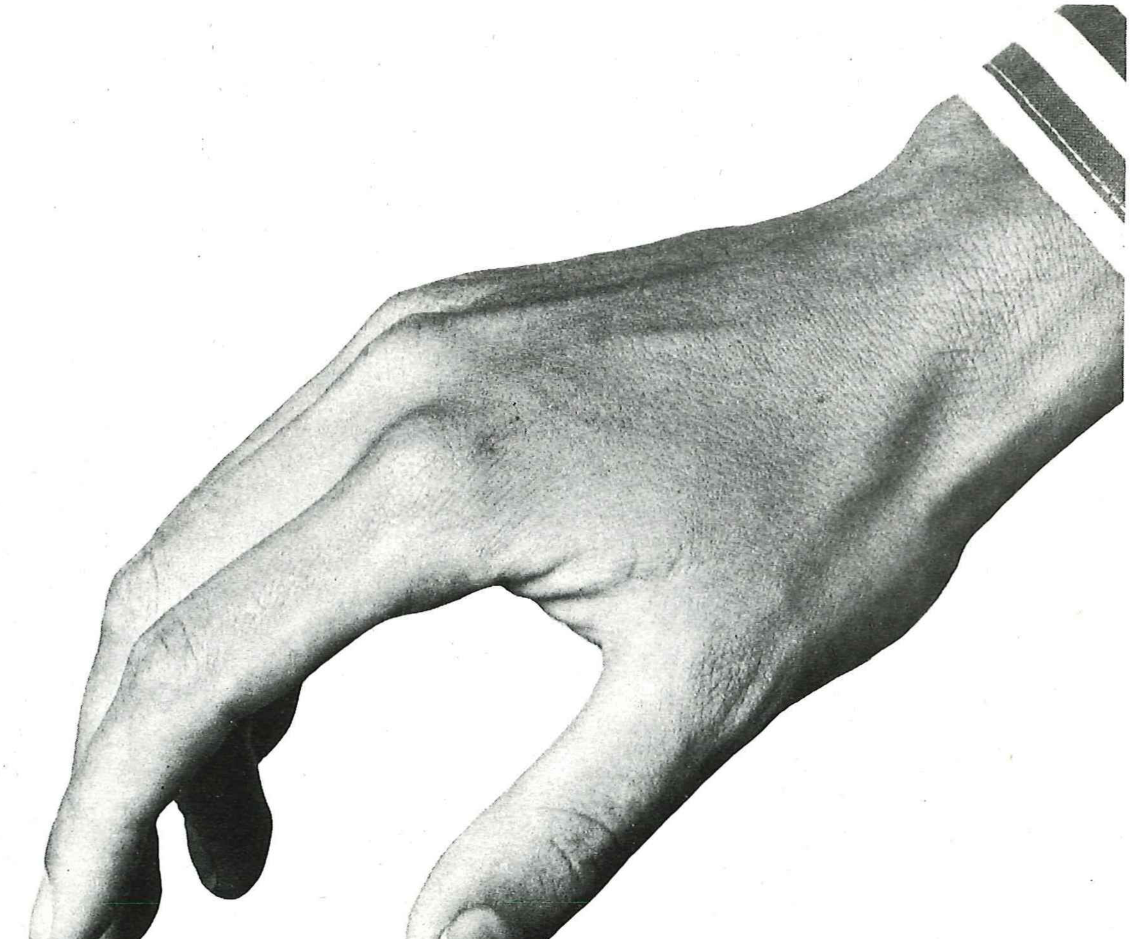

# Always at hand.
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GF3

# An era ends at Abingdon

At seven o'clock on the morning of 26 June half a dozen Post Office engineering apprentices stepped forward to disconnect all but a few lines into and out of the old telephone exchange at Abingdon, Oxon. Their action meant that England's last manual exchange was closing and another important step in the Post Office's plans for a "dial everywhere" network had been made.

Immediately after the old equipment at Abingdon was cut out a new automatic crossbar exchange was switched in and, for the first time, the 6,100 subscribers in this historic Thames-side town were able to dial direct to most parts of Britain. The switch to automatic working also means that the Post Office now has only six manual exchanges still in service – all in sparsely populated areas of Scotland.

The history being made at Abingdon was witnessed by 150 guests who were able to see the very last call handled at the old exchange. The Mayor of Abingdon was connected by an operator to a local firm of solicitors who, in 1896, became one of the six original subscribers in the town and who had kept the same number – Abingdon 4 – ever since.

In parallel with the work of phasing out manual exchanges, the Post Office has been tackling another immense task – Subscriber Trunk Dialling, which was first introduced at Bristol in 1958. While making STD available to more than $12\frac{1}{4}$ million customers, the Post Office has also nearly trebled the size of the telephone network, from $4\frac{1}{2}$ million exchange lines in 1958 to $12\frac{3}{4}$ million now. In all, the Post Office is spending about £800 million a year in capital investment.

As a result of the Abingdon switchover, $99\frac{1}{2}$ per cent of the country's exchange connections now have STD. And in opening the town's new exchange Mr Kenneth Cadbury, Assistant Managing Director, Post Office Telecommunications, said that it was hoped to achieve a "dial everywhere" network in the United Kingdom by the end of 1978.

"From a customer's point of view", Mr Cadbury said, "a three-minute cheap-rate trunk call on your new automatic exchange will today cost you a shade under $5\frac{1}{2}$p – only a $\frac{1}{2}$p more than such a call cost 40 years ago".

**Post Office telecommunications journal**

Summer 1975 Vol. 27 No. 2

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**Cover: An unusual task for Post Office maintenance staff. Leon Pezzack and Bill Turner, based in the Scillies, check the route of an inter-island telephone cable running under a sand bar which is covered at high tide.**

**The benefits of a system which provides a second exclusive exchange connection on an existing telephone line have been clearly demonstrated in Cardiff Telephone Area.**

# Two into one will go

## RE Chapman/WJ Hubbard

MORE THAN three years ago the Post Office, anxious to get greater return on its investment in local telephone cable networks, began feasibility studies into the One plus One Subscriber Carrier system which enables a second exclusive exchange connection to be made to an existing line. Trials have now been carried out in 12 Telephone Areas to study the system's effectiveness and to monitor problems that emerged.

One of the Areas selected to take part in the trials was Cardiff which at the time had the longest waiting list in the country with about 11,000 people requiring service. It was natural, therefore, that the new system was seen as an important step forward in efforts to reduce the queue for phones.

At that time up to 30 per cent of all new customer enquiries in the Area were immediately put on the waiting list, while a further 25 per cent could only be offered the restrictive shared service facility. Although accepted as a temporary expedient to overcome current difficulties, shared service has always been the source of many irritations for customers and the Post Office alike and there is, of course, a national policy for its eventual elimination.

Although the One plus One Carrier should not be automatically used as an alternative to shared service it is worth noting that it has no practical difficulties with the provision of extensions and where numbering schemes are incompatible.

The One plus One Carrier system is connected to a working telephone exchange line to provide a second exclusive exchange connection. It consists of compact, transistorised carrier conversion units connected to the line at both the new customer's premises and the telephone exchange. The second telephone connection operates in the frequency band between 19 and 96 kHz while the original connection continues to work at normal audio frequencies up to 3.4 kHz.

Both circuits use ordinary telephones but components within the carrier units convert the speech and signalling from the carrier telephone into the higher frequency signals which are superimposed upon the voice frequency circuits.

The signals are separated by filters, one within the exchange conversion unit and another fitted externally at the point where the line divides to serve the two customers. Unlike shared service, One plus One Carrier gives not only complete privacy and uninterrupted access to the exchange but also enables both customers to dial and speak to each other.

How then was Cardiff Telephone Area to derive the maximum benefit from the use of such a system? Initially the External Planning Division was given the task of selecting suitable exchanges which contained sections where immediate relief was not planned. In co-ordination with the Internal Planning Division the work was programmed for exchange construction staff to provide the equipment in seven exchanges with mainly residential customers.

By the end of February last year 44 customers had been given service by the use of the One plus One Carrier system. Since then the application of the system has grown substantially. Currently, there are some 800 Carrier subscribers connected and working in 47 exchanges in the Cardiff Area. A further 27 exchanges will be equipped to allow One plus One to be provided and this will mean that over half the Telephone Area will be able to provide this type of service.

The scale of provision of exchange equipment varies between single mounting units for 10 carrier conversions in small automatic exchanges (UAXs) to 30 units at bigger exchanges. A further 18 units are wired up at Cardiff's main telephone exchange.

What of staff reaction during the 18 months that this system has been in use? Naturally external planners prefer to take maximum advantage of the carrier system wherever it is feasible, rather than the alternative method of preparing a minor relief scheme which must necessarily take longer because of the need to slot it into the Works Division programme. This latter method also tends to fragment planning effort down to isolated pockets rather than the more desirable long-term programming of cabinet/exchange relief schemes.

On occasion it has been found beneficial to provide One plus One Carrier as a temporary measure. Soon after the trial began an exchange unit was provided at a UAX and 10 customers were given service by One plus One Carrier. Later the Works Division completed a planned development of this exchange which involved the provision of many additional distribution poles. The exchange unit was then recovered and transferred to another UAX where line plant problems existed.

The advantages of using this method include speedy service to the customer, immediate revenue from connection, rental and call charges, and minimal initial planning effort.

After a tentative start the Installation Division accepted the challenge of providing One plus One Carrier and both installers and fitters accept its use as part of their everyday work load. It is interesting that field staff have not only proved the versatility and advantages of such a system but have demonstrated once again that their knowledge, experience and common sense have been able to overcome most of the teething troubles that invariably arise with new techniques.

This, together with the help and guidance that has been readily available from the staff of Telecommunica-

tions Development Department (TDD) in London, has kept things running smoothly and also provided much additional data which will prove beneficial in future development.

A good example of how this close co-ordination between Telecommunications Headquarters paid dividends concerned the batteries used for powering the exchange unit. The power is obtained from the 50-volt exchange battery while a small secondary battery charged over the line provides power for the customer's carrier equipment. It was found that the small 10-volt batteries sometimes became discharged while in store, and at the time of installation, particularly on busy lines, fault conditions such as speech cut-off and incoming ringing difficulties arose.

Because of these problems a battery charging unit capable of charging up to ten 10-volt batteries at a time was developed in the TDD laboratories at Alperton. It is now possible therefore to ensure that all batteries are fully charged when issued.

One plus One Carrier equipment is intended primarily for use by residential subscribers because with the high calling rates which can be met on business lines there is a risk that the battery would not be maintained in a fully charged condition.

In Cardiff Telephone Area, however, the view has been taken that every opportunity should be taken to exploit the potential of One plus One Carrier and it has been used selectively on business lines. The few faults which have resulted are adequate justification for this policy.

The scope for One plus One Carrier on business lines could be increased by the use of local mains-power units as an alternative to charging the batteries over the lines. There would remain, however, technical restrictions on the use of the carrier for some business services and while these can be overcome there are no plans at present for extending the scope of the system.

Maintenance of the One plus One Carrier system is relatively easy because no adjustments or measurements have to be made to the carrier frequency levels. The only requirements are that the line should be within normal maintenance insulation limits and the loop resistance should not be greater than 1,000 ohms.

The method used for clearing faults proved to be in the carrier equipment is immediate replacement, having first proved the audio and carrier line and telephone. And to reduce out of service time and travelling to a minimum it has been found necessary to hold sufficient spare carrier units at various points. Spare units are also carried by the faultsman.

In the early days items were often returned to stores as being faulty by both installation and maintenance staff, but were subsequently proved to be in working order. The number of items being returned has now reduced considerably as staff have become more familiar with the equipment.

For ease of testing and to avoid disturbance at the customer's premises a portable tester using the substitution method has been built by maintenance staff for use in Cardiff exchange area. This has proved very successful and enables an independent test of either audio or carrier equipment to be made at any connection point in the line between the main distribution frame ▶

**The audio line of a One plus One system is tested at Cardiff's main telephone exchange. The lower telephone is used for testing the carrier line.**

and the particular premises concerned.

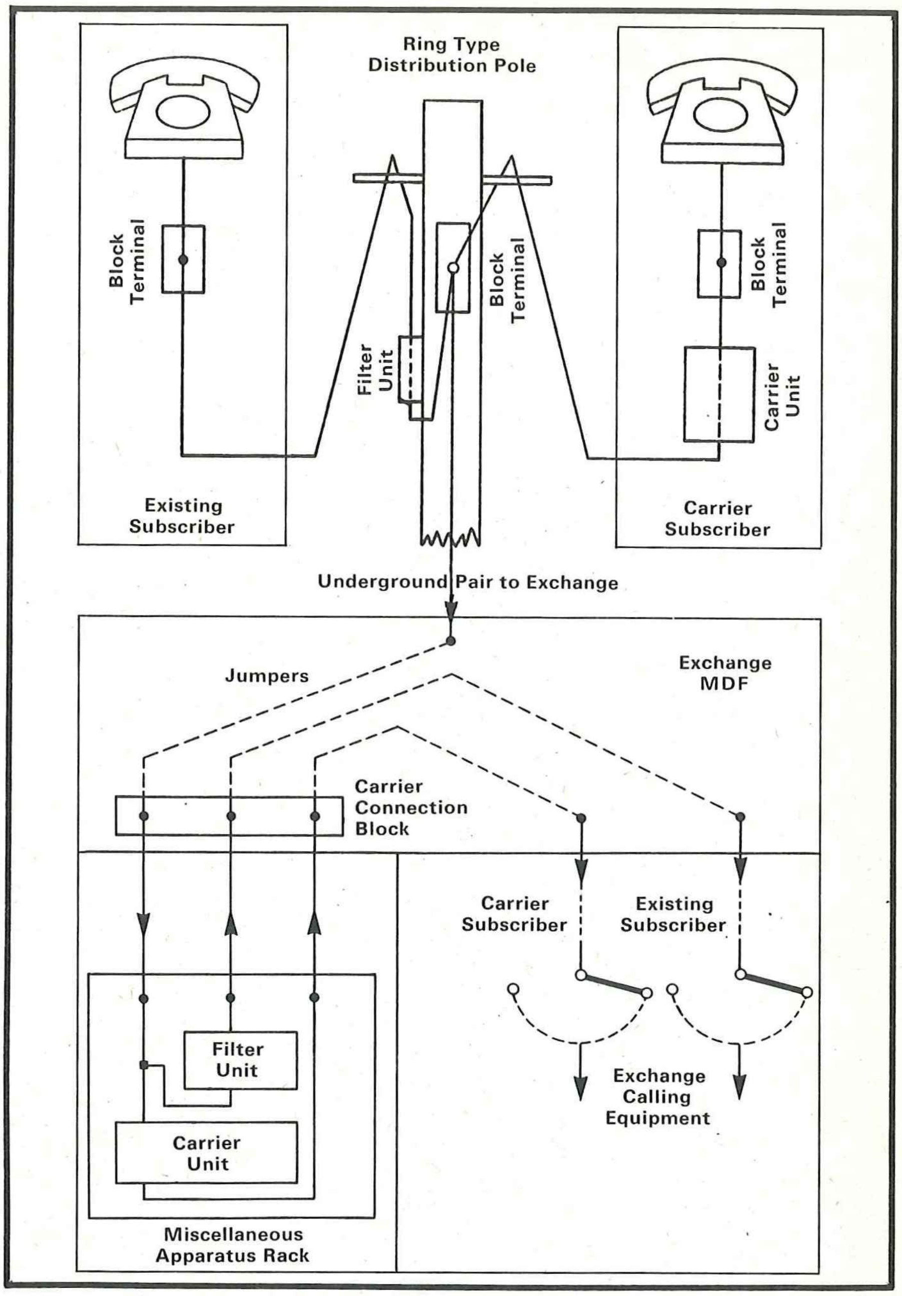
The test consists of two telephones (one audio and one carrier) plus the appropriate items of equipment, mounted compactly in a box. A local circular has also been issued on One plus One maintenance and the maintenance handbook for carrier system (WB 900) consisting of all relevant Telecommunications Instructions was issued to each exchange where the equipment is fitted.

Reported faults include a faulty exchange unit jack contact, noisy underground lines, radio interference on the carrier line, and a filter unit having been damaged by lightning. In the larger installations it is important that repair service control and exchange records are maintained correctly to ensure that carrier circuits can be readily identified for quick and efficient fault clearance. Increasing experience and improved testing techniques before and after fitting will result in better service for telephone customers.

In addition to the 800 carrier subscribers already connected a further 500 carrier units and 125 exchange mountings have been planned, including an additional holding for forecast exchange transfers. This indicates Cardiff's confidence that "two into one *will* go" and that the One plus One Carrier system can provide extra flexibility in the planning and provision of exchange lines. And with ever improving technology the question might well be posed: How long before the advent of One Plus Three, Four or Five?

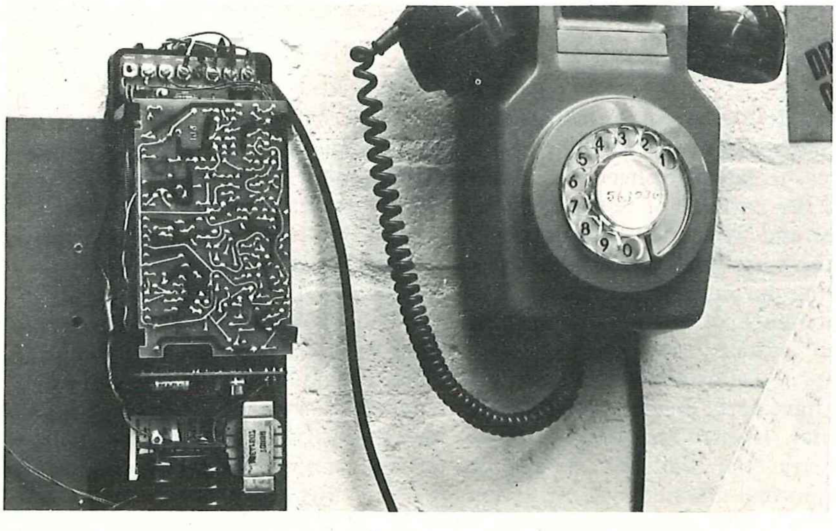
**Mr R. E. Chapman** and **Mr W. J. Hubbard** are Efficiency Engineers in Cardiff Telephone Area and have been responsible for field trials of the One plus One Subscriber Carrier system in the Area.






**One plus One subscribers' stations and telephone exchange connection.**

**Below left: A subscriber's carrier conversion unit (with cover removed) connected to a working line. Right: A small filter unit is fitted to a distribution pole for connection to the block terminal on the left.**



# Wideband network improves ICL's connections

## RM Streatfield and JB Waites

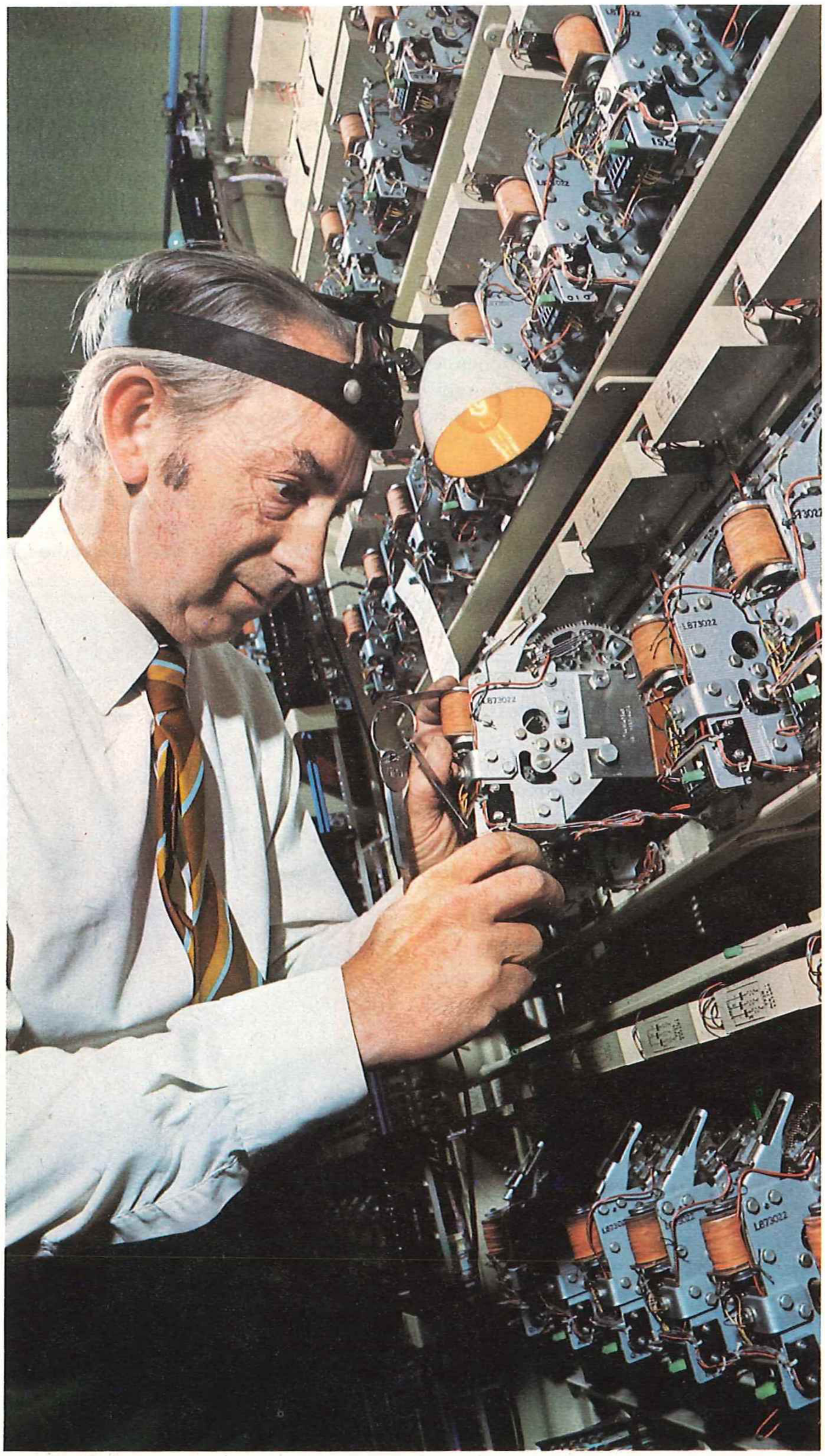
A LARGE private circuit trunk network providing telephone and data communications to 24 exchanges with about 8,000 extensions up and down the country has been designed and installed with Post Office help for International Computers Ltd, the biggest commercial and scientific computer manufacturers outside the United States of America.

The network uses fully automatic tandem switching centres which interconnect calls to and from all locations via Post Office wideband facilities which provide circuits in groups of 12, each circuit consisting of a frequency bandwith of 4 kHz on a multi-channel carrier system. A maximum of five groups (60 channels) form a supergroup. Wideband facilities form the main links between the 10 principal locations of the company.

Early indications are showing the new set up to be an excellent example of how to use new equipment in conjunction with existing facilities. The result for ICL is vastly improved intersite telephone service with considerable financial savings.

But to begin at the beginning. International Computers Ltd began operations in 1968 following a merger between International Computers and Tabulators Ltd (ICT) and English Electric Computers Ltd. The company is independent and international with marketing activities in more than 60 countries and employs about 29,000 people. Its headquarters are at Putney in London and the main factories are situated at Letchworth and Stevenage in Hertfordshire and Kidsgrove, Winsford and West Gorton, near Manchester in the North-West.

The idea of a private telecommunications network for ICL was born in 1969 following a random sampling of the company's telephone traffic initiated by the late Len France, Com-▶



**Post Office maintenance engineer Charles Parker makes an adjustment to the register controlled motor uni-selector equipment at ICL's tandem switching centre in London.**

munications Adviser and a former Post Office man. This revealed a high rate of inter-company calls most of which were being made via the public switched telephone network and it was quickly obvious that there would be a potential cost saving if a private network were introduced.

As a result a telecommunications advisory study was undertaken by the Post Office involving a detailed analysis of calls. The results confirmed the viability of a discrete network to cover all the major ICL locations in the United Kingdom but it was decided to make it trunk only as it would still be more economical for local calls to be made via the public switched telephone network and a number of point-to-point circuits already existing.

At about the same time the Post Office was introducing wideband facilities for rental by private customers. These had the advantage of allowing spare capacity which could be brought into service at relatively short notice and they generally work out cheaper to rent than the corresponding number of separate circuits. They also allow cheaper forms of signalling than the voice frequency type.

This type of network where private circuits are switched by dedicated tandem switching centres (TSC) provides a way of economising on the use of long distance circuits by concentrating them into single routes between the TSCs. In the case of ICL their premises were then connected to the network by a single route of private circuits to the nearest TSC.

The three main centres in London, Letchworth and West Gorton are directly connected to each other by 240 kHz wideband supergroups of up to 60 channels while other wideband routes connect Bracknell, Kidsgrove, Birmingham, Leeds, Putney, Winsford and Stevenage to their respective TSCs.

Of the three types of switching equipment considered – crossbar, Strowger and register controlled motor uni-selector (RCMU) — the third was finally selected because of its greater flexibility and improved switching speed over Strowger, its ability to provide a full availability of 40 outlets compared with 10 on Strowger and the fact that it was cheaper than crossbar. RCMU equipment works on the Strowger principle but is motor driven and mounted on open racks.

A multi-frequency signalling crossbar system offering faster switching could have been provided but apart from the increased cost to realise the full benefits of such a system, it would have been necessary to provide comparable PBXs at all peripheral locations. This could not be justified until the mid 1980s when it is considered that most of the larger PABXs within the company are relatively new.

The TSCs for the network have been located at Euston in London, Letchworth and West Gorton, the two outside the capital being alongside existing PABXs and the London tandem being directly linked by cable to the existing installation at Computer House, Euston, nearby.

The principal advantages of this scheme are that the siting of the TSCs enabled the local private circuits from ICL premises to be within the 24 kilometres range of DC signalling and that should additional premises need to be connected and require full access to the network this can be easily set up. There is also the point that the register controlled switching equipment chosen for the tandem enables standard dialling codes to be used throughout the network. This makes for much easier compilation and production of an internal company directory, for instance.

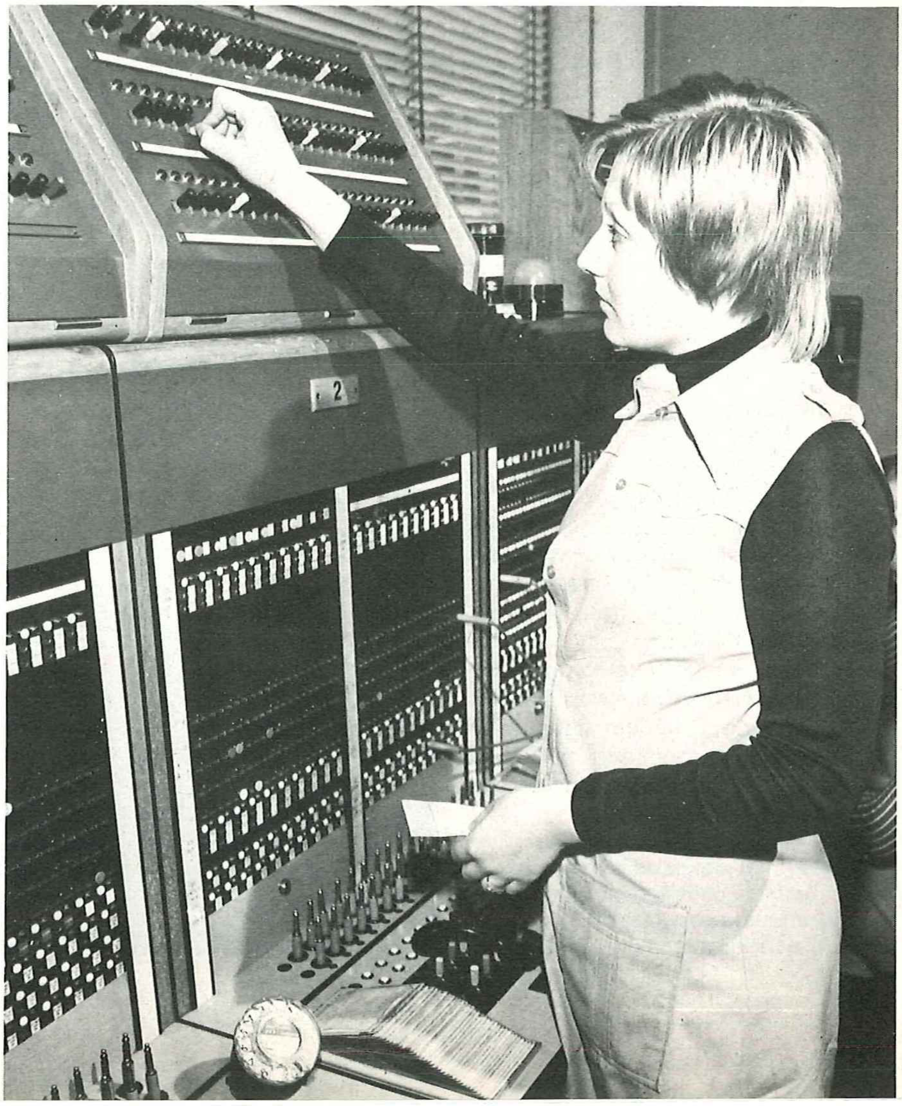
Calls through the tandem exchanges from one PABX extension to another are made direct by dialling a standard three-digit code followed by the extension number. Because the RCMU switching system is register controlled, it translates the routing information given by the second and third digits of the dialling code before switching the call through the next tandem exchange to the distant PABX.

The extension number is stored at the originating tandem exchange until the link is established with the required PABX. Then the register completes the connection by pulsing out the required extension number. A PABX extension wishing to make a call to an extension on a PMBX would dial the appropriate three digit dialling code.

Ringing tone will be heard from the called switchboard until the operator answers and completes the call in the normal way. PMBX operators can dial through the tandem to other ICL PMBXs or straight through to the extension on a PABX.

Only two types of private circuit relay sets are used throughout which gives a greater level of flexibility when

**A telephone operator at the PABX in Computer House, London, shows how a faulty circuit on the ICL private network can be easily isolated by operating a switch on the test and busy cabinet.**



any changes are made. Relay sets, for instance, can easily be moved from one route to another.

Another important aspect studied during the design period was the requirement for data transmission between company premises. Although at the time immediate needs were fairly small it was anticipated that a fair amount of growth would take place. As a result a major requirement seemed to be a growing need for dedicated data circuits and in this respect it was decided to exploit the spare capacity available on the widebands to create a surplus of four wire channels which could be used to satisfy most inter-site dedicated circuit requirements.

A national grid of 60 channel wideband supergroups has been provided linking Putney, Euston, Bracknell, Stevenage, Letchworth, Kidsgrove and West Gorton. The benefit of this grid to ICL is that spare channels can be made available for data transmission between the main centres of the company at little cost and at short notice.

Data transmission on these channels is at speeds of up to 2,400 bit/s using Post Office modems. It is also expected that the switched network will be used for data transmission although this will be carefully controlled by ICL so that it does not conflict with the pattern of speech traffic.

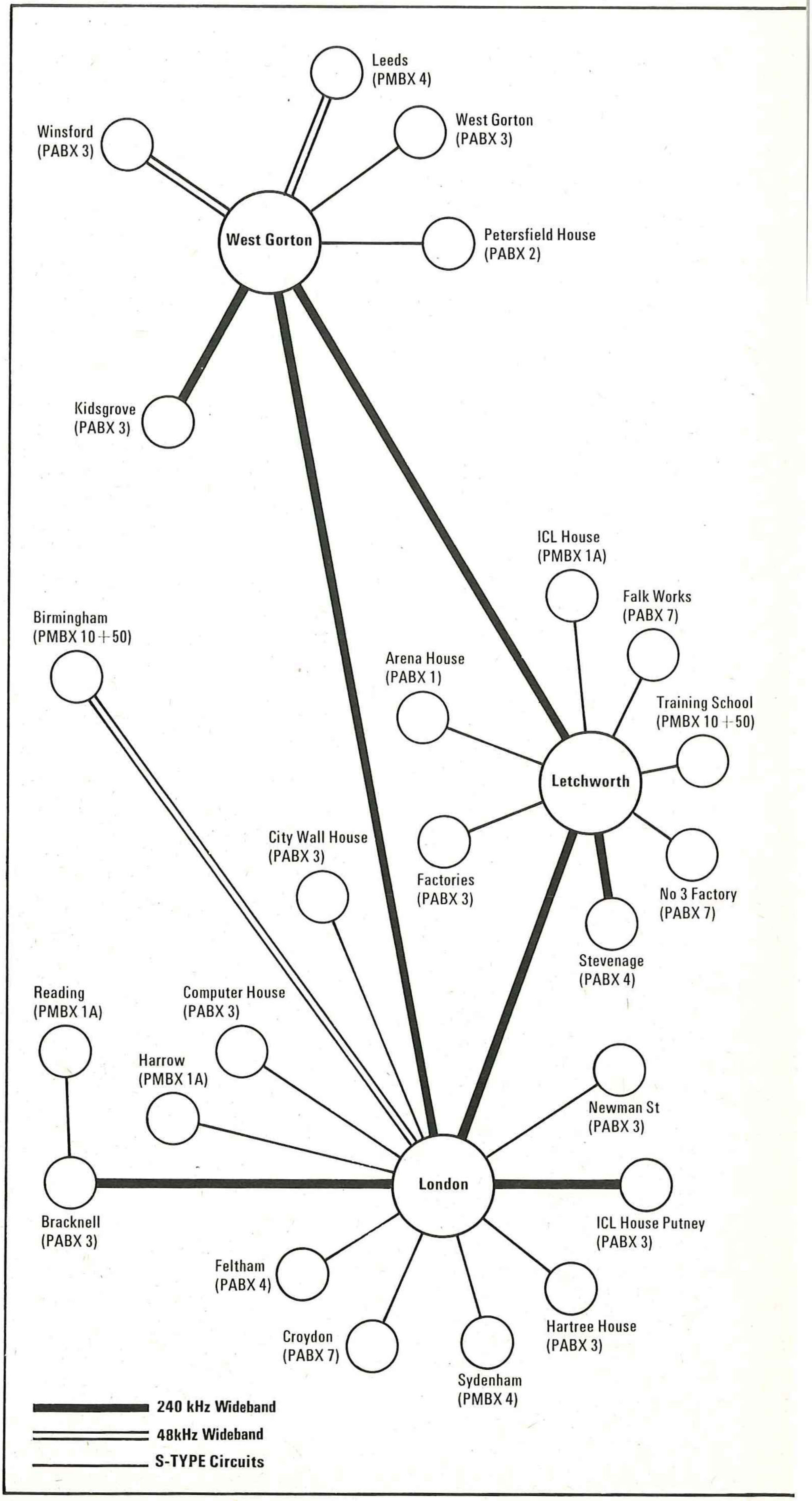
The complete system, all circuits, PBXs and the tandem centres, is maintained by the Post Office as an integrated network. A Network Service Liaison Officer has been appointed in LTR/North Central Area and his function is to co-ordinate remedial action where problems arise outside the scope of the individual repair service centres.

Management of the project was co-ordinated by THQ Marketing Department with the expertise of THQ Service and Network Planning Departments. Implementation was carried out by a project engineer and project manager in the General Manager's Areas responsible for the installation of the tandem centres. Throughout the whole scheme regular progress meetings were held on a national and regional/area basis.

**Mr R. M. Streatfield** is a Senior Sales Superintendent in Telecommunications Marketing Department and a member of the team responsible for customer liaison.
**Mr J. B. Waites** is Group Telecommunications Manager of ICL, and was formerly a Post Office engineer in Bradford Telephone Area.

PO Telecommunications Journal, Summer 1975

**The ICL private trunk switched network, showing links between the three tandem switching centres and company PBXs.**



# Helping to develop electronic chips

## RE Hines

**Integrated circuits – tiny chips of silicon into which thousands of electronic components are built – are becoming increasingly important in telecommunications system development. To aid development of these devices by Post Office engineers, Research Department provides facilities for converting new designs into working circuits.**

A MAJOR change in technology is taking place in Britain's telecommunications system as electromechanical switching gives way to electronic techniques. In this change the millions of electromechanical relays and switches of a typical switching system are being superseded by electronic components.

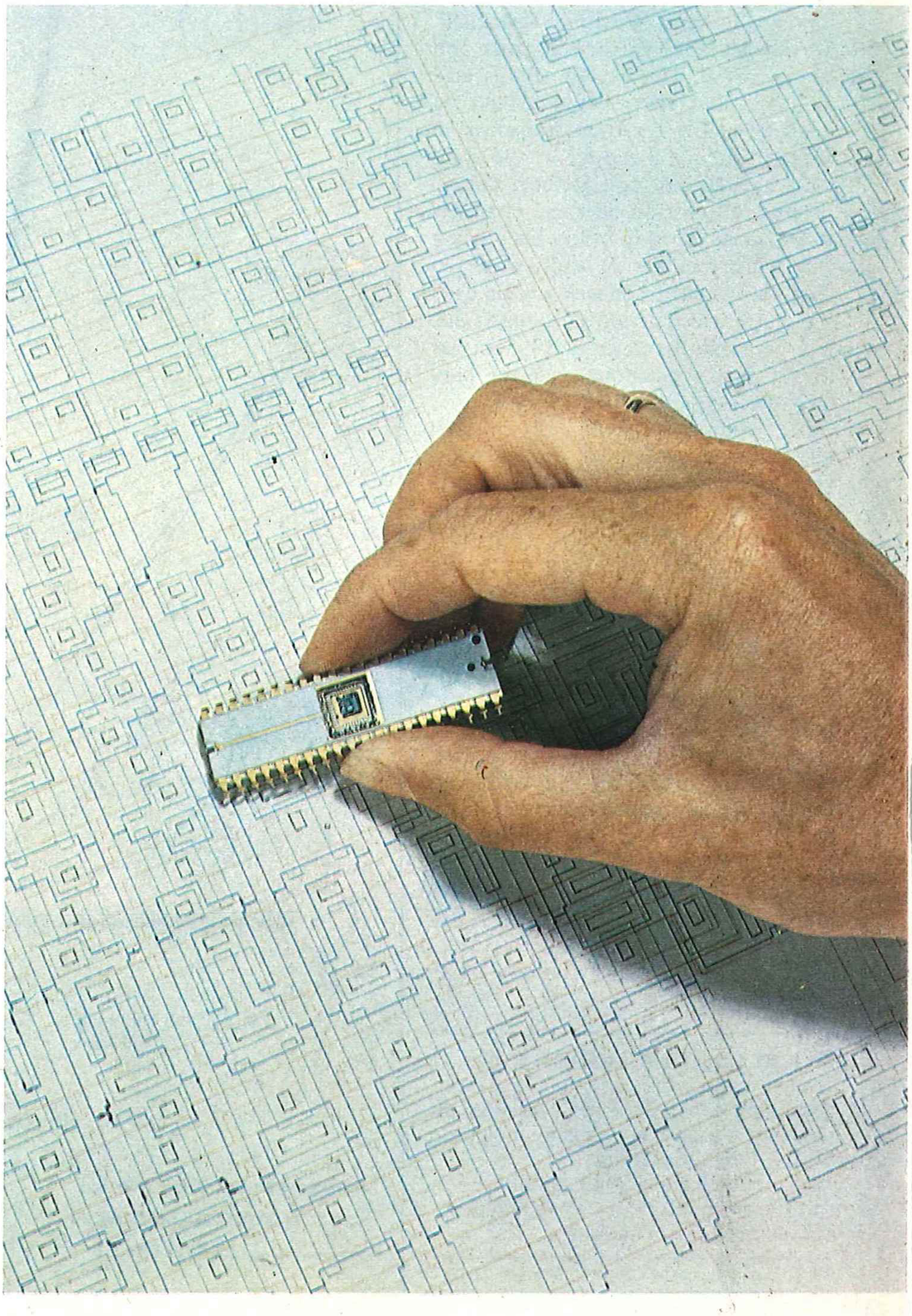
In recent years a wide variety of circuit techniques have been made available to designers of electronic equipment, with the trend towards smaller components. The large scale integration of components now possible provides savings in weight and space, as well as reducing the number of soldered joints required in a circuit. This in turn results in greater reliability and simplifies maintenance.

Many Post Office system developments described in Telecommunications Journal over the last few years have indicated the trend towards micro-electronic circuit techniques. At the heart of these systems lies a tiny device known as an integrated circuit – a chip of single crystal silicon into which thousands of transistors, resistors and other components are built and interconnected. A single chip may vary in size from 4 sq mm to 25 sq mm, according to the complexity of the circuit structure.

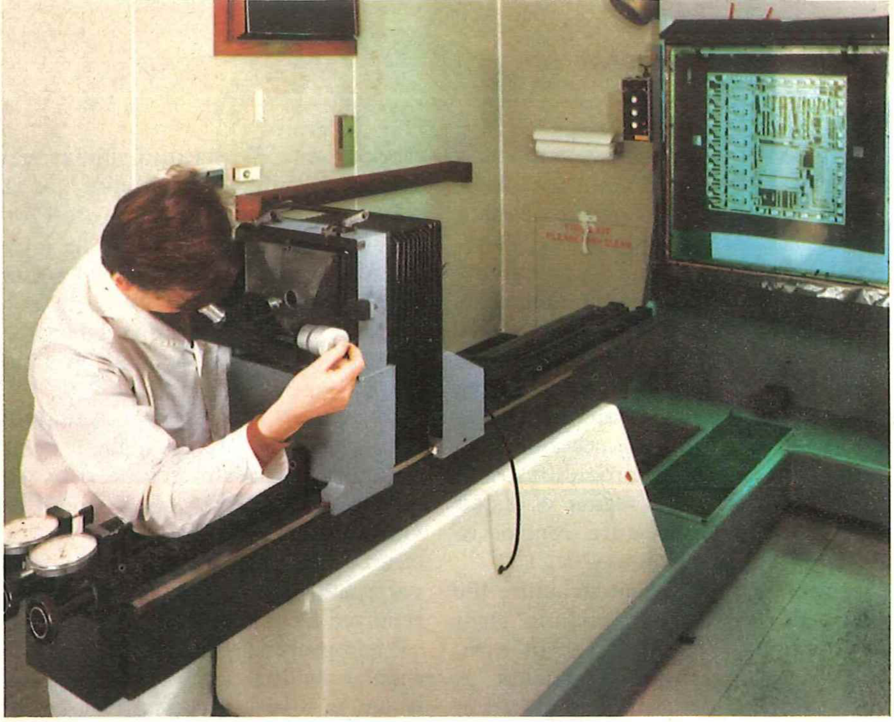
The growing importance of micro-electronic circuit techniques in telecommunications development can be gauged from the fact that this year alone the Post Office will need two million integrated circuits. In five years this figure will have risen to seven million, and by 1985 no fewer than 10 million will be required.

Integrated circuits can vary in form from a few electronic gates – which are similar to switches – in a configuration which has many applications, to a very complex circuit involving thousands of active components specially arranged to meet one specific need. The simple form is readily available from numerous markets, and normal Post Office methods of obtaining this type of device should ensure adequate supplies.

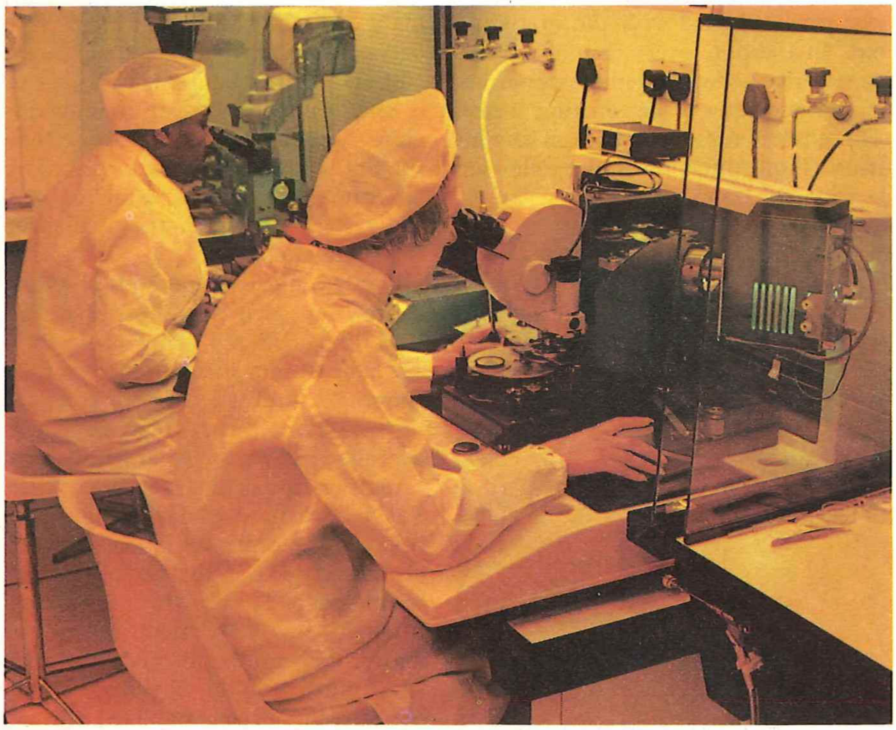
However, as the more complex integrated circuits are often of very limited application they cannot be easily obtained, especially in the small quantities that may be needed to field test a system exploring new techniques. A section was therefore set up in the Post Office Research Department



**An integrated circuit package. The tiny silicon chip containing the circuit is placed in this housing so that it can be attached to the system in which it will function.**



Artwork for one layer of an integrated circuit is illuminated on the screen while the camera is set for the first stage of photographic reduction to produce the necessary photomask used in later processing.



Middle: In a clean room at Dollis Hill photomasks are carefully aligned with the integrated circuit patterns on silicon wafers, ready fot the next stage of contact printing.

at Dollis Hill, London, to study integrated circuit technology. One of the main aims of this section is to provide facilities in which circuit designs prepared by Post Office development engineers can be converted into working circuits on an experimental basis.

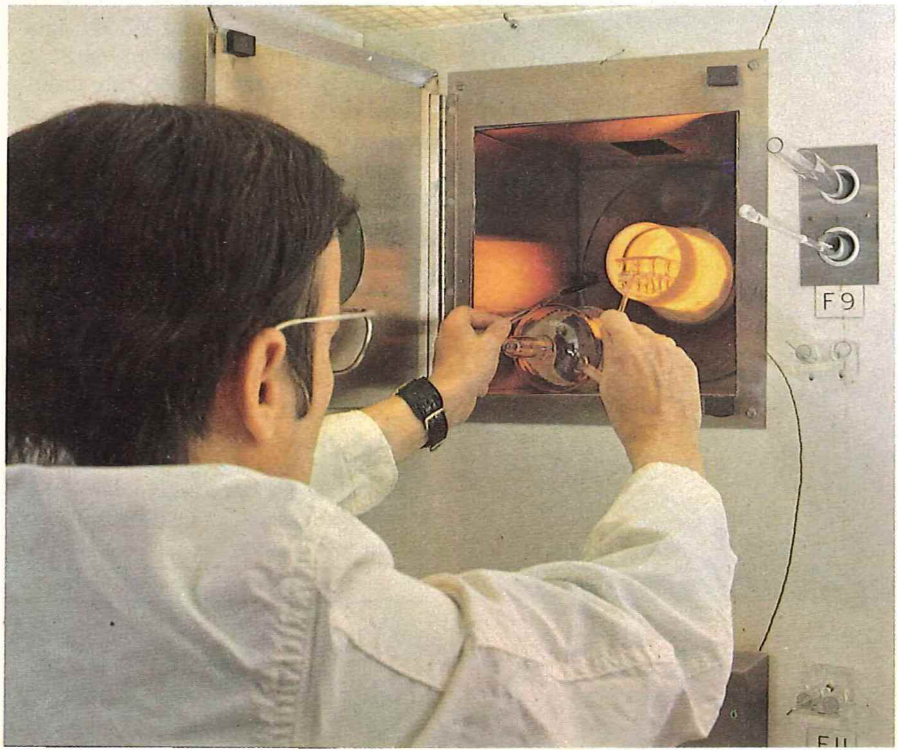
The facilities provide a relatively inexpensive and quick means by which the engineers' ideas can be proved before full-scale manufacture. By carrying out this work "in-house", liaison problems are reduced to a minimum, ensuring rapid response and correction to difficulties that may be encountered at any stage as the work proceeds.

Development engineers prepare their circuit layout designs either by large-scale drawings or by using a computer aided design system. In each case the desired dimensional data is produced in punched tape form which can be used to control an automatic draughting machine, called a flat bed plotter.

The plotter prepares artwork by cutting the appropriate shapes in a highly stable plastic film consisting of two laminations, one transparent and the other opaque. Only the opaque layer is cut and the unwanted material is peeled off.

This production process is known as "cut and strip" and has the effect of converting a line drawing into the positive and negative images necessary for later reduction in size by photographic means. Usually a series of five patterns is required to build up the successive layers needed to make the circuit function.

Typically the artwork is 200 times the final device size. The next stage in production therefore is to prepare a set of photomasks from the artwork by two stages of photographic reduction. The photomasks are made on glass either by the well known silver halium emulsion process used in developing ▶




Silicon wafers, each containing hundreds of identical circuit patterns, are placed on quartz "boats" and loaded into an electrically heated furnace to undergo an oxidation process.

normal black-and-white photographs, or the harder and more durable pattern media of chromium.

Each completed photomask contains hundreds of identical circuit patterns, obtained by repeated exposures from the original using a step-and-repeat camera. These patterns are arranged in rows with just sufficient separation to enable each device to be pared from its neighbour when processing and testing has been completed. In this way many circuits can be processed at the same time from a slice of silicon which itself is only about two inches in diameter and 250 microns deep – five times the thickness of a human hair.

To produce the circuits the silicon wafer is processed through a succession of thermal and photolithographic steps by which the alternate layers of conducting and insulating materials are formed and shaped. Altogether some 50 steps are involved, and overall processing takes about eight days.

A photolithographic step is carried out by first coating the silicon wafer with a film of light-sensitive compound known as photo-resist and then exposing this by contact printing through a photomask. After exposure the photoresist film is developed to reveal the required pattern. This is then hardened by baking so that it will survive in the very corrosive etches which are then used to define the structure of the device. Electrically heated furnaces are used to perform the necessary diffusion and oxidation procedures, and these operate in the region of 1,000 deg C, with temperature control to better than plus or minus $\frac{1}{2}$ deg C.

To build up the circuit structure the photolithographic and etching steps are repeated for each layer in turn, using the appropriate photomask. A high degree of precision is required in this work to ensure that each layer is accurately aligned with the preceding one. In addition, every chip of the silicon wafer undergoes microscopic examination after each etching stage. This ensures rapid feed-back of any intrinsic fault, thus preventing following work from suffering in a similar way.

Great cleanliness is required at all stages of processing as minute traces of chemical impurities accidentally introduced would degrade electrical performance and reliability. Dust particles of the size found in normal laboratory environments would completely obliterate parts of the circuit.

To achieve the required standards, only chemicals of the highest purity obtainable, specially processed for the electronics industry, are used. All the vital operations are carried out in clean rooms or on clean benches where particles larger than $\frac{1}{2}$ micron are removed from the air by special filters.

When processing has been completed each individual circuit in the silicon wafer is tested for electrical performance by using needle-like probes to make the required connections between the terminal pads of the circuit and the test equipment. Only then is the wafer divided into individual chips, each containing a circuit. Finally, these chips are placed in separate housings for attachment to the systems in which they will eventually function.

By adopting strict methods of quality control at each stage of processing ResD has achieved yields of up to 50 per cent from a silicon wafer on quite complex circuits. This compares favourably with the widely recognised average yield rate in work of this type.

Another important feature of the ResD work is to ensure compatibility between the proposed layout design of an integrated circuit and processing technology. To do this a process's capabilty in both electrical performance and minimum physical dimensions must be fully documented. This has already been completed for two well known processes – known as P channel metal gate and silicon gate – and work is in hand to add the more difficult N channel silicon gate process.

The present trend towards the large-scale use of integrated circuits in electronic systems underlines the importance of ResD's work in this field. Clearly, its capability to provide Post Office development engineers with facilities for converting new ideas into hardware will ultimately help to speed up their introduction into the telecommunications network.

**A diamond stylus scribes a completed silicon wafer to enable the individual chips to be separated.**

**Mr R. E. Hines** is head of the group in Post Office Research Department responsible for the development of metal oxide silicon (MOS) integrated circuit technology.

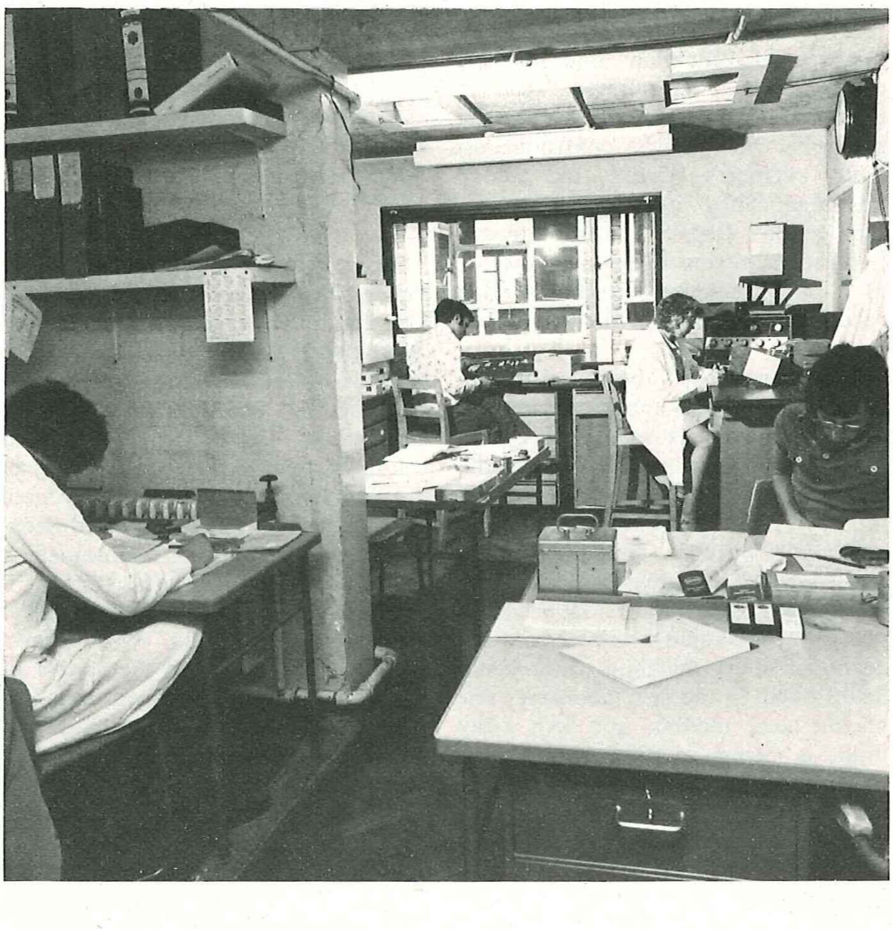
PO Telecommunications Journal, Summer 1975

# Modern home for the quality analysts

## RJ Feasey

The new building at Fordrough Lane, Birmingham, which will house laboratories of the Post Office's Quality Assurance Division.

Below: Part of the building which the new laboratories will replace.



A MODERN, purpose built block housing vital laboratories for the Quality Assurance Division of the Post Office's Purchasing and Supply Department is due to open in Birmingham later this summer. It will replace a small "temporary" laboratory opened in 1950 and intended to last 10 years. The move will mean that much of the work now squeezed into odd corners will be carried out in a much more suitable environment with scope for future expansion.

The new building, constructed on the open-plan principle throughout, is situated close to existing P&SD accommodation in Fordrough Lane and will be home for more than 100 people working in the Materials and Test Sections of QA Division – the staff whose job it is to ensure, by stringent testing, that the Post Office gets full value for the millions of pounds it spends on stores and equipment.

The new Birmingham Materials Section (BMS) Laboratory will be the only one in the Post Office organised to provide a fully integrated metallurgical and inorganic chemistry service for research, development and quality assurance. It is also fully equipped to deal with air pollution problems which can arise near industrial areas and which can affect sensitive Post Office ▶

transmission and switching equipment.

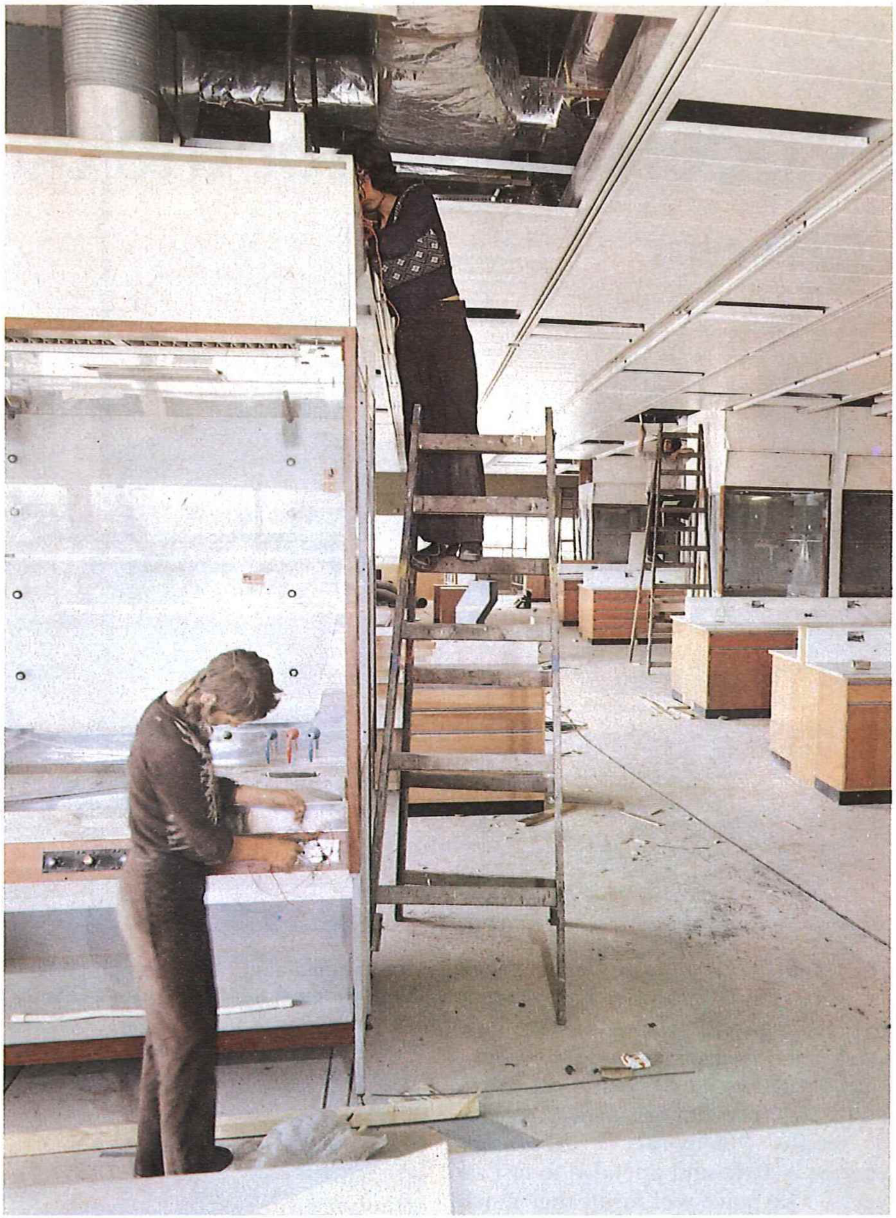
In all it is a far cry from the laboratory opened 25 years ago which has prefabricated concrete beams and an asbestos sheet roof and where 50 staff are crammed into a complex designed originally for 30 people.

The Materials Section will use the ground floor of the new two-storey building for the Metallurgy and Contact/Component Physics groups whose work involves examining anything from the failure of a vehicle wheel to a relay spring which loses its tension. These groups will share a new scanning electron microprobe analyser and an electron microscope which will be used to investigate phenomena such as high resistance contacts in relays and reed switches.

There will also be an area with ample facilities for "ageing" apparatus under accelerated conditions using environmental cabinets into which equipment is placed while the temperature and humidity are adjusted. This is important work for the design of future components, because corrosion and wear is examined and analysed by teams of qualified chemists, physicists and metallurgists.

The upper floor will house the chemistry staff and, as well as the chemical analysis of materials and components, this is where work carried out on behalf of the Post Office's Occupational Health Service will be tackled. The work will include asbestos identification and particle count in air dust analysis, lead in blood and various other chemical problems which might confront Post Office engineers. Already the section has been called in by one Telecommunications Region to estimate the quantity of nitrous fumes near the site of a new telephone exchange and a report was prepared for the local medical officer.

These tasks will be carried out alongside modern analytical procedures which will ensure that all equipment whether it be an aerial on a radio tower or a shovel used for digging trenches is economically suitable for its intended purpose. The radiographic service, which examines equipment for internal faults, has until now been restricted by the room available and the degree of safety shielding which could be installed. In the new laboratory one of the most modern 400 kVA x-ray units is being installed which can penetrate four inches of steel or nine inches of aluminium. The whole unit is mobile and this will allow for maximum flexibility of use.



**A fume cabinet is installed in the new Materials Section laboratory, which is now nearing completion.**

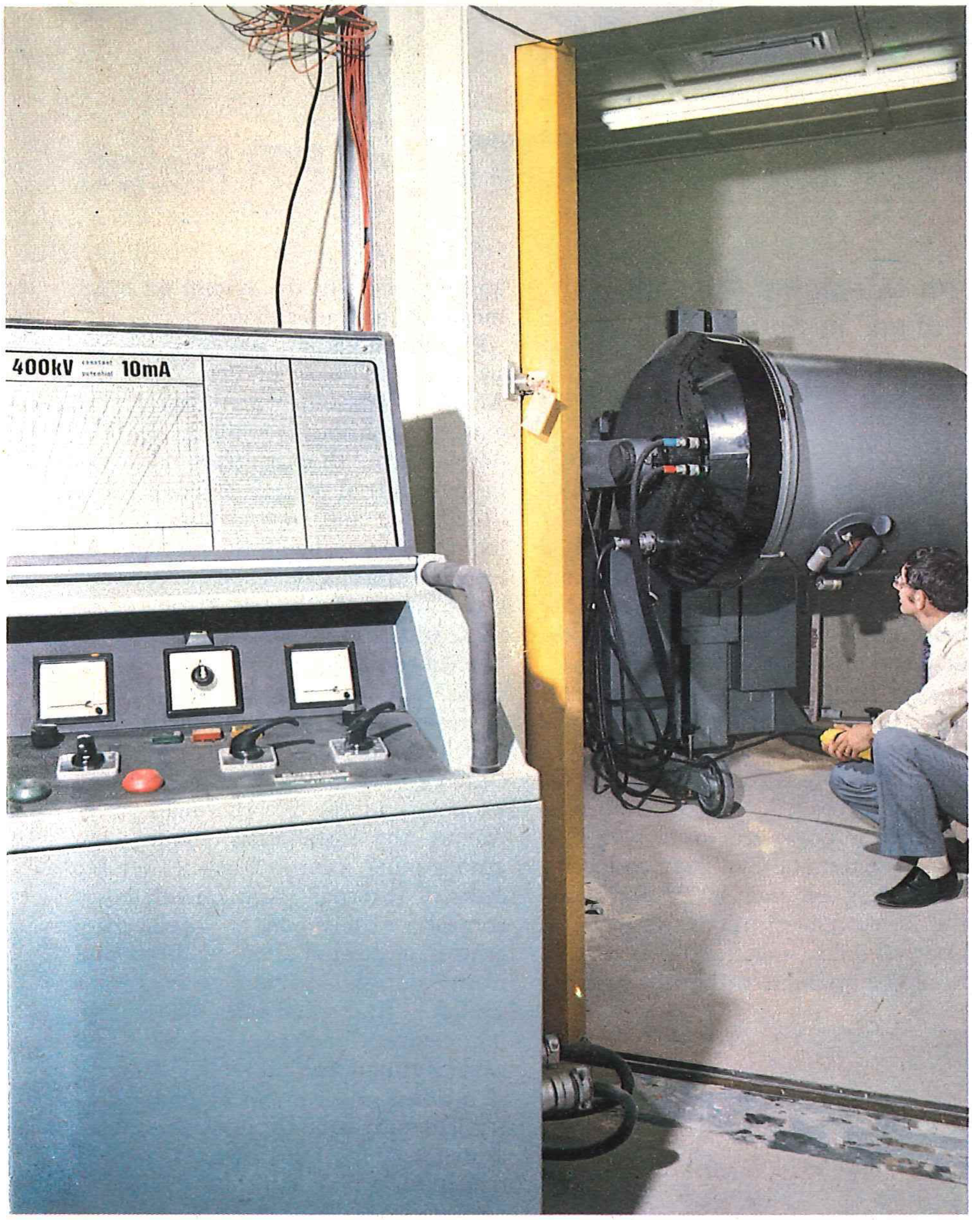
The new air conditioned Post Office Prime Mechanical Standards Laboratory run by Birmingham Test Section (BTS) staff is on the ground floor. The laboratory maintains the highest grade non-electrical standards which form an essential link in the international traceability chain. The precise value of the Post Office standards is monitored by direct reference to the United Kingdom national standards maintained by the National Physical Laboratory.

Post Office staff make non-electrical measurements dealing with length, mass and force during the course of their work and if these measurements are to be meaningful it is vital that they must be made with instruments that are compared regularly with known standards of greater precision.

Standards themselves, of course, go back a long way in history and were even mentioned in Magna Carta. Indeed the inch was once defined as "the length of three grains of barley corn, dry and round" and the foot was "the length of the king's foot". The yard was "the distance from the king's nose to the tip of the second finger on his outstretched arm".

Modern standards, however, have to be much more precise, stable and capable of inter-comparison and the chain of standardisation has to extend right down from the accepted international standards to the instruments, like micrometers, used for day-to-day measurements.

When fully established the new BTS laboratory will seek the approval of the British Calibration Service (BCS) for a wide range of metrological parameters to supplement the BCS approvals for electrical parameters already




**The mobile X-ray unit, installed in the Materials Section laboratory, can penetrate four inches of steel or nine inches of aluminium.**

awarded to the London and Birmingham Test Sections of QA Division. This will enable spare calibration capacity to be made available on a repayment basis to other industrial organisations as well as to the rest of the Post Office.

Quality Assurance support activities will also be much in evidence in the new building. There will, for instance, be in-depth electrical testing and inspection of a wide range of electrical and electronic equipment and components submitted by BTS staff responsible for QA surveillance and inspection at suppliers' works.

There will also be facilities for testing equipment under particular conditions and life testing of electrical and electronic equipment such as transmission apparatus. Testing of complex components, particularly semi-conductors will be carried out for the benefit of BTS staff at works and for Telecommunications Headquarters development groups in general.

Standardising and developing methods of test and inspection for automatic exchange equipment is another activity. This will involve liaison with QA Division staff at works and with contractors and development groups, production of inspection guides for use by QA Division staff at works and development of special tools and gauges, for example, for checking two-motion selectors.

Elsewhere clerical staff will order, record, file and distribute the documentation necessary for the efficient operation of BTS groups responsible for quality assurance at suppliers' works and BTS QA support groups. Associated activities will include operation of the QA registry which controls and progresses the flow of samples sent into the BMS and BTS laboratories and operation and development of the computer support services for BTS which will store and analyse data from the reliability test results.

The environmental testing of complete items of equipment like amplifiers by the Test Section will be complementary to the Materials Section environmental testing of discrete items and individual components. It is in this field that the two sections become fully integrated in the investigation of service and test bed failures. Items such as transistor and integrated circuit packages which fail life tests will be submitted to BMS for microprobe analysis and examination under the electron microscope to find out the mode and reason for failure.

With such a wide spectrum of important work to be tackled, it is clear why the new building is being warmly welcomed. As well as being designed to meet all practical needs attention has been paid to other considerations.

The laboratories are air conditioned for operational reasons and comfort and services such as electricity are provided on a grid system concealed in the ceiling or floor. The whole building has been designed to be as free from vibration as possible and a hydraulic lift has been installed. Special attention has been paid to lighting and noise levels in that the lights and acoustic tiles have been incorporated into a suspended ceiling.

The main block has been built as a flexible unit so that interior redesign can be carried out with ease. As much as possible has been located in the open part of the building including the writing areas for staff while the central section of each floor has been allocated to the necessarily enclosed activities such as dark room working.

These rooms are constructed wherever possible in partitioning which can be re-erected on other patterns for future requirements. An adjunct to the main block and forming the entrance to it, is a single storey building housing the Materials Section administrative offices, first-aid room, reading room, conference room, tea room and reception area.

**Mr R. J. Feasey** is head of the Birmingham Materials Section in Post Office Quality Assurance Division. The article was produced in collaboration with staff in the Birmingham Materials and Test Sections and at QA Division Headquarters.

# New approach to inside information

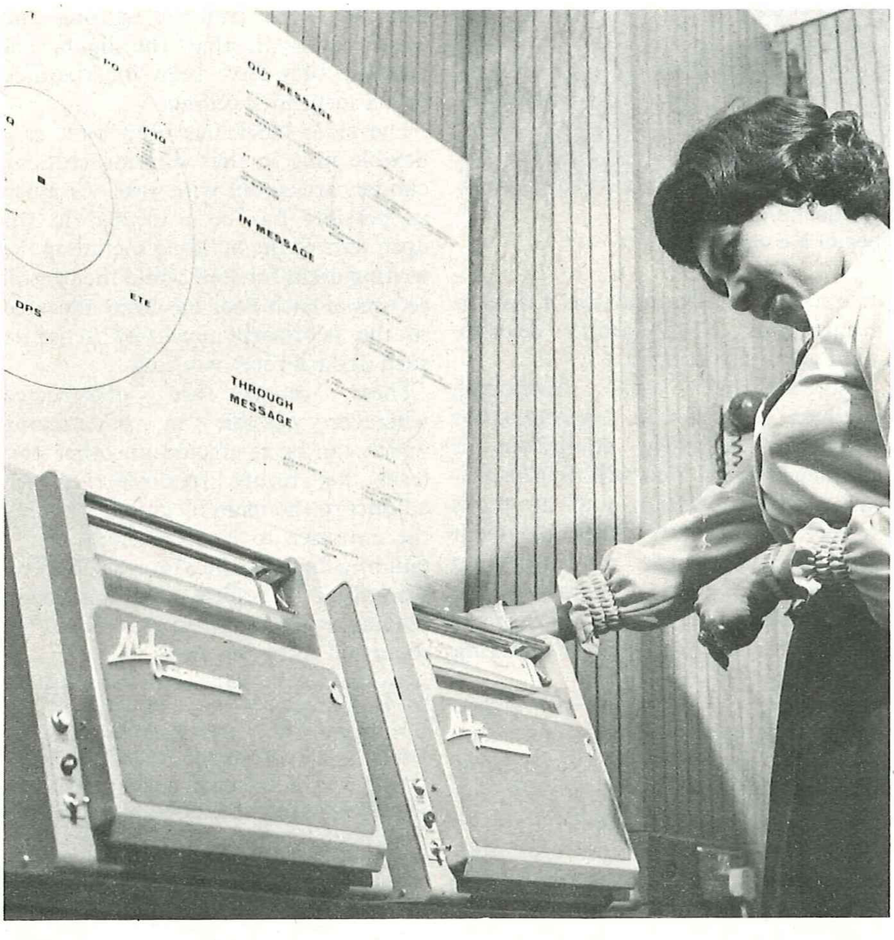
RR Ralph

**Trials have been carried out in two Telephone Areas to determine the likely cost/benefit of an "in-house" facsimile system for transmitting messages within the Telecommunications Business.**

THE PATENT for an "automatic electro-chemical recording telegraph" taken out in 1843 by Scottish inventor Alexander Bain marked the origin of a means of communication known today as facsimile. Bain's device was the forerunner of equipment which enables exact copies of written, printed or graphic information to be transmitted between distant points over the public switched telephone network, private circuits or radio links.

Various improved methods followed Bain's invention, but the high cost of facsimile compared with other conventional means of conveying hard copy confined its main uses to a few fields, such as the transmission of press photographs and weather charts. However, rapid technological advances made in recent years have resulted in the development of facsimile equipment which is suited to a wide range of both specialised and general purpose applications.

In the light of these developments a Post Office study group was appointed to consider various aspects of facsimile, including ways in which it could best be exploited. One recommendation of the group led to an investigation to determine the likely cost/benefit of using a system internally within the Telecommunications Business. It also sought to identify facilities that would be desirable within the business and the effect of the system on other means of communication.




The investigation was carried out by means of trials in two Telephone Areas. Peterborough and Exeter were chosen as, although similar in size and development, they contrast markedly in patterns of customer population, distribution and staff location. These factors allowed the information gained from the trials to be taken as representative of all Telephone Areas except those with a high, densely packed telephone population.

For the trial, facsimile machines operating over the telephone network were installed at 32 regular communication points in the Exeter Area and 28 points in the Peterborough Area. Among the installation points were auto-manual centres, repair service centres, external plant maintenance controls, telephone engineering centres, and installation, planning and works controls. Machines were also installed in traffic and sales offices, typing centres, and pay, registry and general situations.

To assess the equipment and facilities generally available, machines were rented from five manufacturers for the trials. Machines were only able to communicate with others of the same make, and it was therefore necessary to install more than one type in some locations to complete the required links. The nominal transmission speed for all models was six minutes for an A4 size document, although two models could be switched to a faster mode of four minutes and another to a nominal three minutes.

More than 300 staff from a wide range of grades were trained to use the machines. Apart from some initial "bedding down" faults, which were cleared by simple adjustments, the various makes generally proved to be acceptable and for normal correspon-

**In the message relay centre at Telecommunications Headquarters, London, these facsimile machines receive circuit notes direct from Network Planning Department at Stanmore, Middlesex. The notes are then forwarded by teleprinter to Telephone Areas.**

dence the quality of the copy was good.

Staff co-operated closely in the trials but general use of the system was low, each point over the 16-week period averaging only seven transmissions per week in the Exeter Area and 10 transmissions per week in the Peterborough Area. Users indicated that this was due mainly to the speed and ease of use of the usual methods of communication – post and telephone – to which general work requirements are currently adjusted and in many cases systemised.

In the Exeter Area the system was used extensively for relaying details of cable faults from the three repair service centres to an external plant maintenance control. In the Peterborough Area the main use was at Wisbech and Spalding for relaying fault reports from auto-manual centres to the repair service centres, which in both towns are located in separate buildings.

Traffic Divisions made use of the system for returns and statistics, advices of staff situations and for notifying telephonists' sick and leave pay at auto-manual centres. Sales Divisions transmitted instructions, information, customers' letters, customer rental records and typing drafts. In external planning control the system was used for the receipt of documentation from main works and planning groups, distribution point cards from installation centres and copies of diagrams from the drawing office.

Among the general uses to which the system was put during the trials were those for urgent advice notes, reports, miscellaneous forms, diagrams, re-transmission of telex messages, stores lists and schedules.

It is difficult to generalise on the costs of facsimile systems because of the number of variables involved. Basically the four elements of costing are equipment, consumables such as special paper, telephone call charges and labour. Equipment costs vary with the type of machine and whether it is rented or purchased. If purchased, maintenance costs are also involved.

Consumable costs vary according to the type of machine, and telephone costs depend on the time period of use (peak, standard or cheap), the charge rate and the time taken to transmit. Labour costs vary with the time taken both before and on completion of facsimile transmission and the grade of officer using the system.

Results of the trials indicate that the high costs of the system and the unsuitability for transmission of much of the normal documented information – because of its bulk, dimensions or format – prevent a total facsimile system from becoming a viable proposition for "in-house" use with the current generation of equipment. It also seems unlikely that the next generation of machines at expected charges will make the situation materially more cost attractive.

However, facsimile can be cost/benefit justified for certain point-to-point applications, particularly if the documents for transmission are specially designed and the system is planned to exploit the benefits of fast interchange of information. Suitable point-to-point applications include fault reporting between some auto-manual centres and repair service centres where direct fault reporting – that is, customer to RSC – has not been introduced and especially where the AMC and RSC are located in separate buildings.

**A transceiver is set up to transmit an urgent document from the THQ message relay centre to another facsimile machine within the Telecommunications Business.**

With the introduction of point-to-point applications, a network could gradually evolve. This, together with less costly and faster transmission speed machines would, it is considered, lead eventually to the development of an "in-house" system. The achievement of compatibility between all machines will be an important factor in speeding the growth of such a network.

In addition to the need for compatibility, other basic requirements that would be desirable for general use within the Telecommunications Business include unattended answering facilities and automatic line switching from handset to facsimile machine without the need to press a button or switch. A line verification facility would also be useful to ensure, when sending to an unattended machine, that transmission could be started only if the receiving unit was correctly set.

Other basic requirements would be a stop/interrupt facility to enable the receiving officer to stop transmission in the event of faulty reception, thereby obviating wasteful transmission costs, and the capability to select any portion of a document to avoid transmission of unwanted information.

At present facsimile machines are installed in all Regional and Board Headquarters, the message relay centre at Telecommunications Headquarters (THQ), and the Chairman's Office at Central Headquarters. These installations were originally intended for emergency communications only, but their use for day-to-day communications between Regional and Board Headquarters and THQ as an alternative to telex is being encouraged.

Some installations also exist for inter-departmental point-to-point applications in THQ and a few Telephone Area Offices are using the system for fault reporting. Further requests for point-to-point applications are being held pending acceptance by the Council of Post Office Unions (COPOU) of the general use of facsimile.

A basic national network therefore already exists, and with the addition of cost or service justified point-to-point applications using compatible machines a national "in-house" system will almost certainly develop. It is considered that "in-house" facsimile will have no appreciable effect on the normal internal post or messenger services, and the internal telex service is also unlikely to be immediately affected. However, if growth of facsimile is not artificially inhibited, then a decline in telex traffic should occur as the facsimile network develops. The amount of traffic generated will be relatively small compared with telephone traffic, and can be discounted for equipment planning purposes.

**Mr R. R. Ralph** is head of a group in Telecommunications Management Services Department responsible for the evaluation and introduction of office machinery in the Telecommunications Business.

PO Telecommunications Journal, Summer 1975

# In the space of ten years...

Mr George Banner, Area Manager Goonhilly, h
communications satellite – in reality the size of
In the background is one of the earth station's t

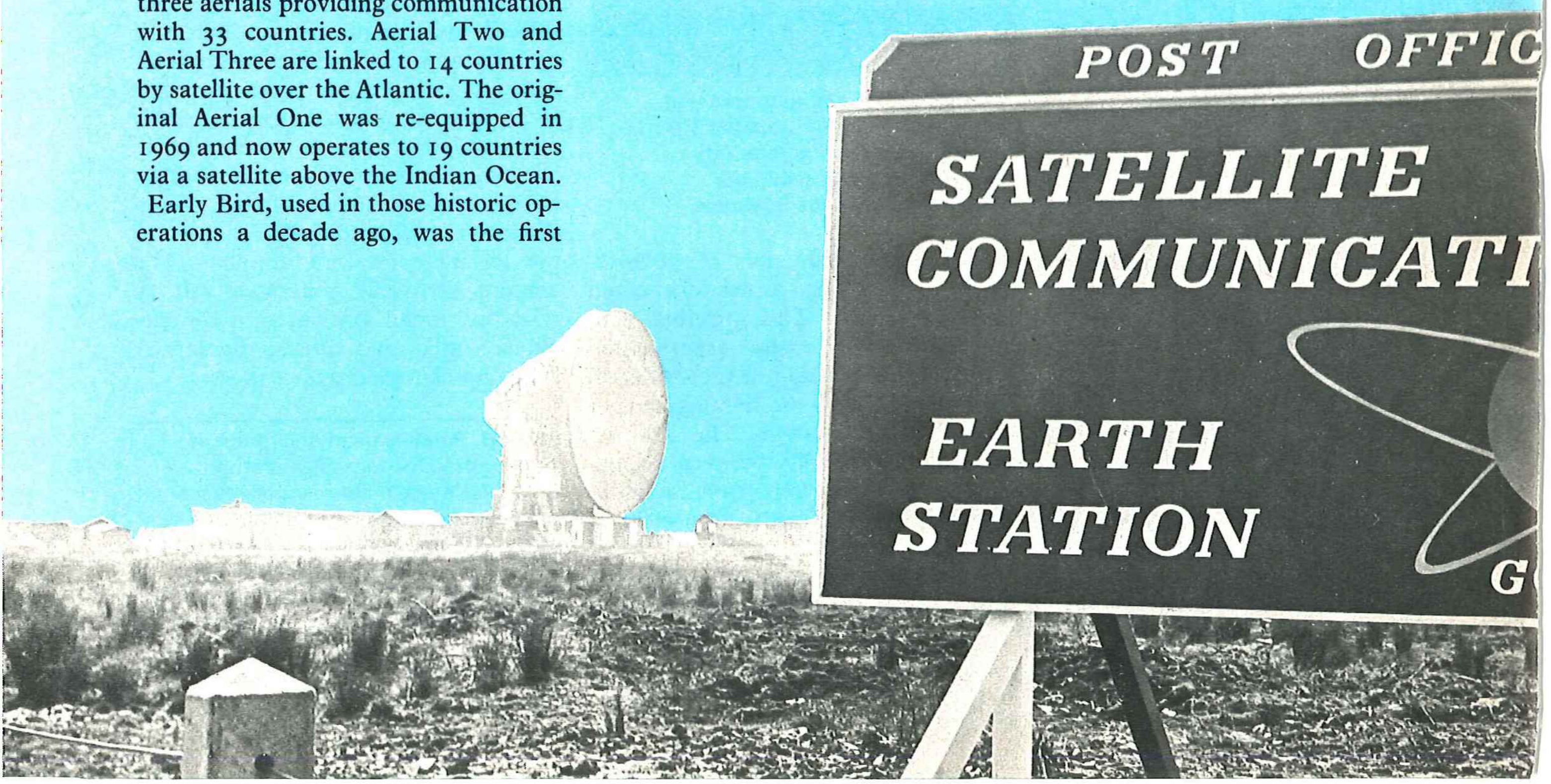
ON A BLEAK moor in Cornwall ten years ago space-age communication was born. For it was in the summer of 1965 that the Post Office's satellite communications earth station on Goonhilly Down began commercial operations, beaming telephone calls across the Atlantic through the Early Bird satellite. Today the earth station links Britain with countries all over the world by sending and receiving telephone, television and data signals to and from satellites some 22,300 miles above the Earth.

In that first year Goonhilly, with one aerial carrying 24 telephone circuits, handled 40,000 transatlantic telephone calls. This was fewer than a tenth of all international calls made to and from Britain. Now, with three aerials carrying 1,300 circuits, it handles about 8½ million intercontinental calls a year – more than half the total made to and from this country.

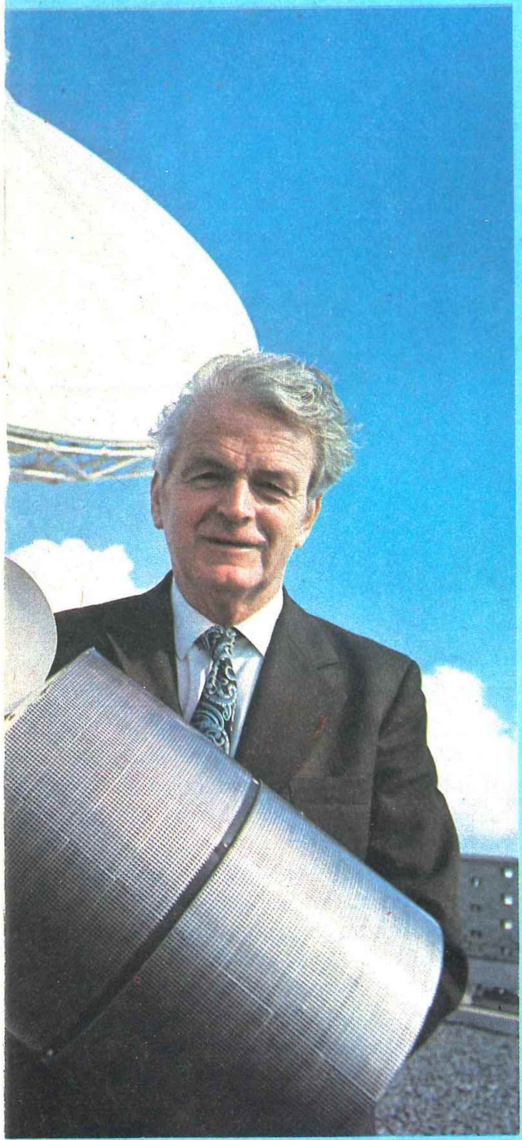
Altogether, more than 60 per cent of the world's intercontinental telephone traffic is now carried by satellites, and there is a global network of 88 earth stations in 64 countries operating a total of 111 aerials. Goonhilly is one of the busiest of these stations, with its three aerials providing communication with 33 countries. Aerial Two and Aerial Three are linked to 14 countries by satellite over the Atlantic. The original Aerial One was re-equipped in 1969 and now operates to 19 countries via a satellite above the Indian Ocean.

Early Bird, used in those historic operations a decade ago, was the first commercial geo-stationary satellite and had a capacity of 240 circuits. Calls were made between America and Europe through five earth stations and the satellite also made possible the transoceanic transmission of uninterrupted live television. Now the Earth is girdled by seven satellites owned by the 91 member countries of the International Telecommunications Satellite Organisation (INTELSAT) in which Britain has the second largest investment share. These satellites are of the series IV type which are capable of relaying more than 4,000 telephone calls simultaneously, as well as high-quality colour television signals.

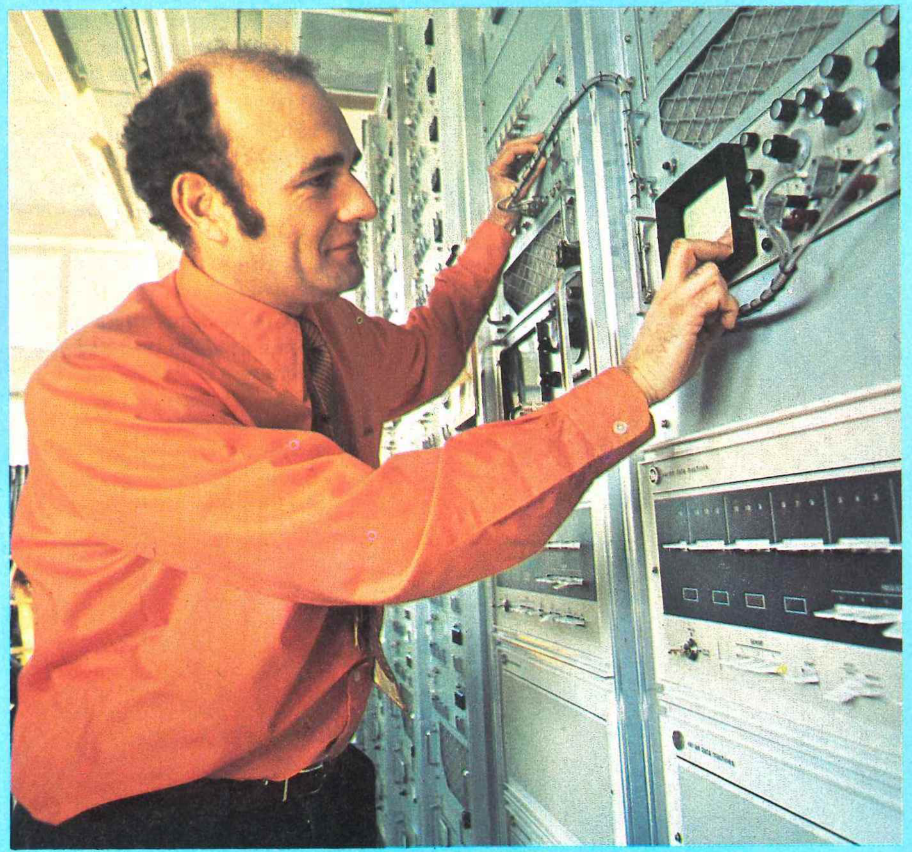
In all this spectacular development of global communications Goonhilly has built up an impressive list of achievements. It was the first European earth station to take part in telephone-by-satellite tests, the first to transmit colour television signals, the first to transmit by satellite a live television programme from Europe to America, and the first to receive television transmissions from Australia.



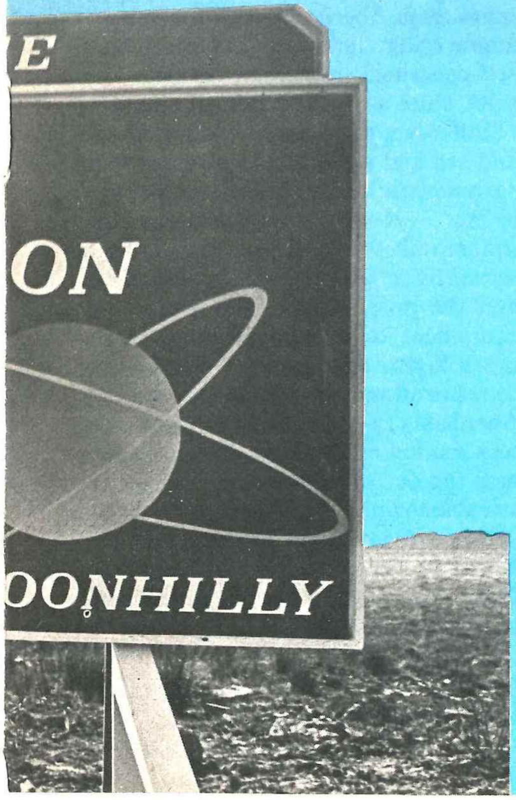
At the touch of a button in the control room at Goonhilly, Post Office telephonist Anne Moyle makes contact with earth stations in other parts of the world. In less than half a second her voice is transmitted to and back from satellites over the Atlantic and Indian Oceans.



olds a scale model of an INTELSAT IV
a double-decker bus.
hree aerials.



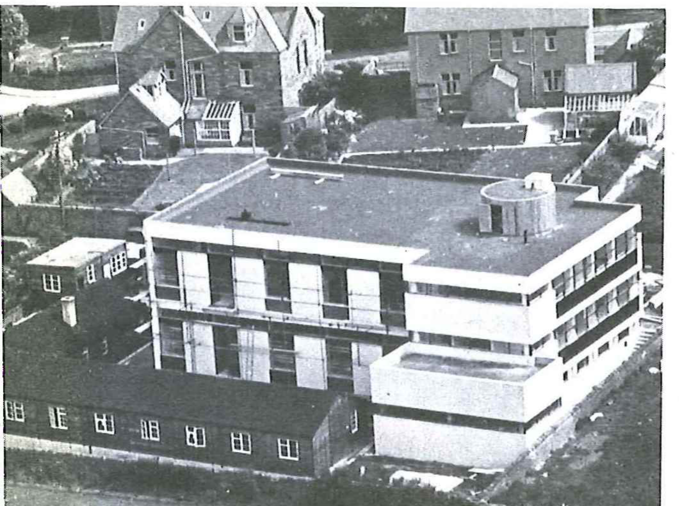
A check is carried out on the digital transmission system, known as SPADE, installed at Goonhilly. In contrast to the more usual practice of assigning blocks of channels to a particular route, this equipment automatically assigns individual pairs of channels through the satellite to different routes as the traffic demands.



# When the oil men came to town

A Cameron

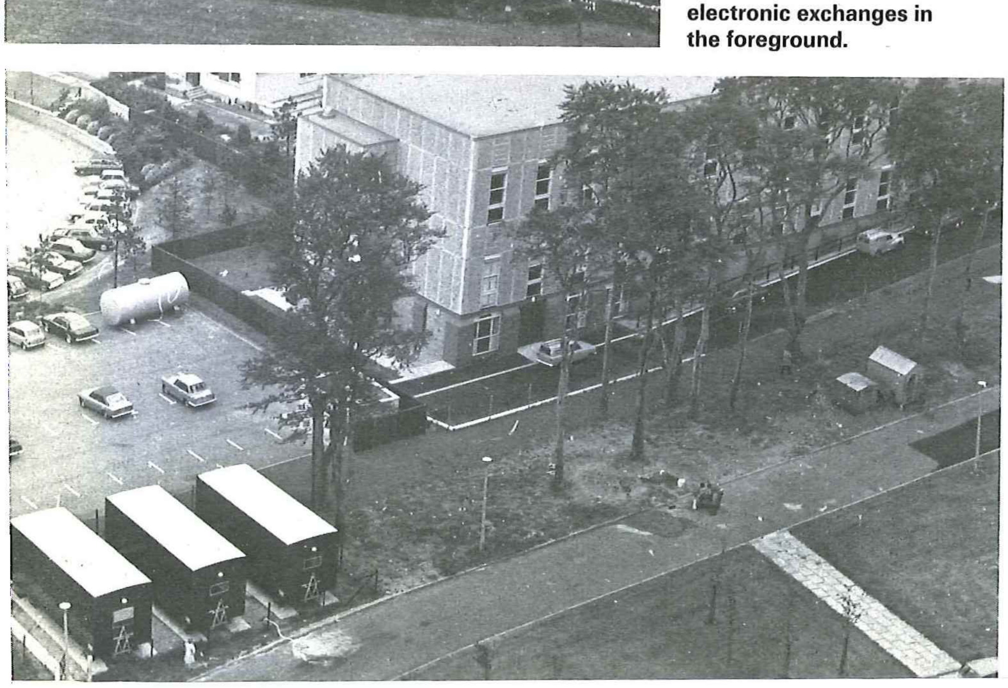
**With the explosive growth in energy-related exploration of the North Sea, demand for telecommunications facilities by shore based interests has had a profound effect on planning and development in Aberdeen Telephone Area.**



**Above: Highland Two, a huge production platform jacket under construction for BP's Forties Field, dwarfs the dockside buildings at Nigg, Ross-shire.**

**Left: The TXK1 automatic telephone exchange at Kirkwall, Orkney, brought into operation last year. It replaced a manual exchange housed in the adjoining huts.**

**Below: Ashgrove TXK1, a new satellite non-director exchange in Aberdeen, which is scheduled to open next year. It will supersede the mobile electronic exchanges in the foreground.**



BLACK GOLD. Texas tea. In other words, oil. Not exactly gushing up in our backyards, but out there in large quantities 100 to 200 miles offshore under the storm-tossed waters of the North Sea.

Oil is having an impact on the whole Scottish economy and all Scottish Telecommunications Board Areas are involved to a greater or lesser extent. Developments so far have, however, mainly affected Aberdeen and North of Scotland Telephone Area.

This Area is very extensive, stretching from just south of Aberdeen, north to Orkney and Shetland and west to the Hebrides. Its land mass is about 18,000 square miles and Unst in Shetland, for example, is farther from Aberdeen than Newcastle-upon-Tyne is from London. There is a large out-stationed headquarters at Inverness (105 miles from Aberdeen) with a complete engineering territorial division and self-contained customer service and sales units as well as clerical support.

Staff cover the Area by road, rail, air and sea and some journeys take about 12 hours each way. Telephone density is low – about 12 telephones to the square mile working on 424 exchanges served by 27 group switching centres – and the proportion of line plant and equipment to telephones in use very much higher than normal. The largest concentrations of population are in Aberdeen (185,000) and the south-eastern section of the Area, and in Inverness (32,000) which is the only other sizeable town.

Before about 1970, the whole of the North of Scotland had for long suffered from high unemployment and population decline. By then, however,

things were becoming stabilised with agriculture, fishing and forestry enjoying a fair degree of prosperity and tourism experiencing a boom. Telephone growth rates had been steady, usually lagging somewhat behind those of the United Kingdom as a whole, but not subject to such rapid fluctuations because of tariff changes and the like.

Waiting lists were virtually non-existent and system growth was about five to six per cent a year compared with the UK's seven to eight per cent. Trunk call growth at around seven to nine per cent was about the same as the UK rate. The Highlands and Islands scheme to convert all remaining manual exchanges to automatic working and introduce STD everywhere was by now under way.

Then in 1971 things really began to happen as exploration activities for oil and gas moved northwards. Considerable uncertainty existed about the possible scale and duration of developments and for a time there was a credibility gap before it became generally accepted that an explosive and continuing growth situation existed and that provision of the infrastructure required to support these massive operations would make unprecedented demands on resources.

Priority for exploration activities then became national policy. Aberdeen and Peterhead emerged as the principal administrative and supply centres with the Cromarty and Inner Moray Firth areas becoming major centres for fabrication and other heavy industrial projects. Orkney and Shetland became natural locations for pipe-line landfalls and oil terminals and forward supply bases.

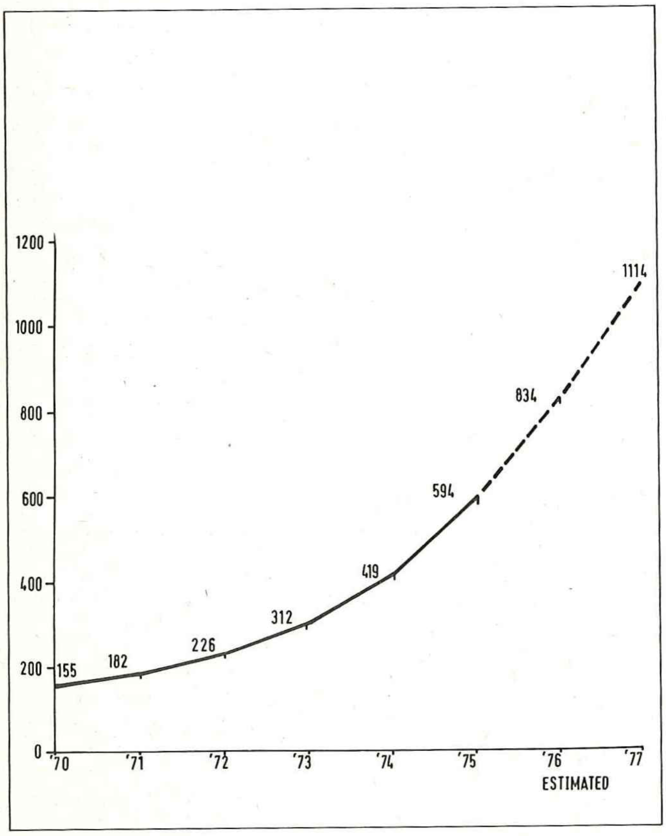
Telecommunication requirements for the oil industry fall into two categories – off-shore and on-shore. Exploration rigs and, following them, production platforms produce the main off-shore commitment. A description of the facilities being made available by the External Telecommunications Executive, at first via the coast radio stations at Stonehaven and Wick, and shortly via two new trans-horizon radio stations, one near Fraserburgh and one in Shetland, was given in the Spring 1974 issue of the Telecommunications Journal. One company – BP Petroleum Development Ltd – operate their own tropo-spheric scatter system from their base at Dyce to the Forties Field 110 miles east of Aberdeen.

The main involvement in the Area has been with the facilities needed for the shore bases to service the oil rigs and platforms and the numerous and diverse companies employed in support. These range from massive platform fabrication and pipe-coating and storage yards, through supply boat operators, drilling contractors, mud suppliers, helicopter bases, diving specialists, tool makers, geological survey companies down to specialist caterers and suppliers of sundries of all kinds. At the last count, more than 260 companies in Aberdeen and district were directly involved in the off-shore oil industry with another 350 providing indirect products and service.

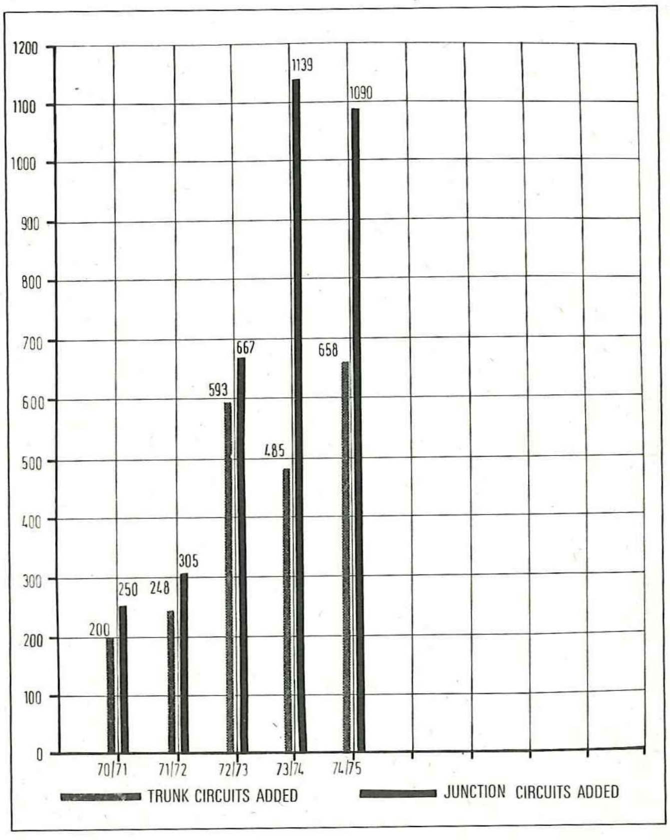
All these people are in a hurry, and their speed of operation is impressive. So, it quickly became evident that the Post Office would have to adopt vigorous and unorthodox measures to match such enterprise and drive. An Area Oil Projects Team was set up towards the end of 1971 to collect and evaluate information about the likely primary and secondary developments and set in motion the necessary planning or execution of works to meet expected demands. The members went about their task with enthusiasm, and for a time the Area probably had more information than anyone about the influx of new companies and the growth plans of local ones.

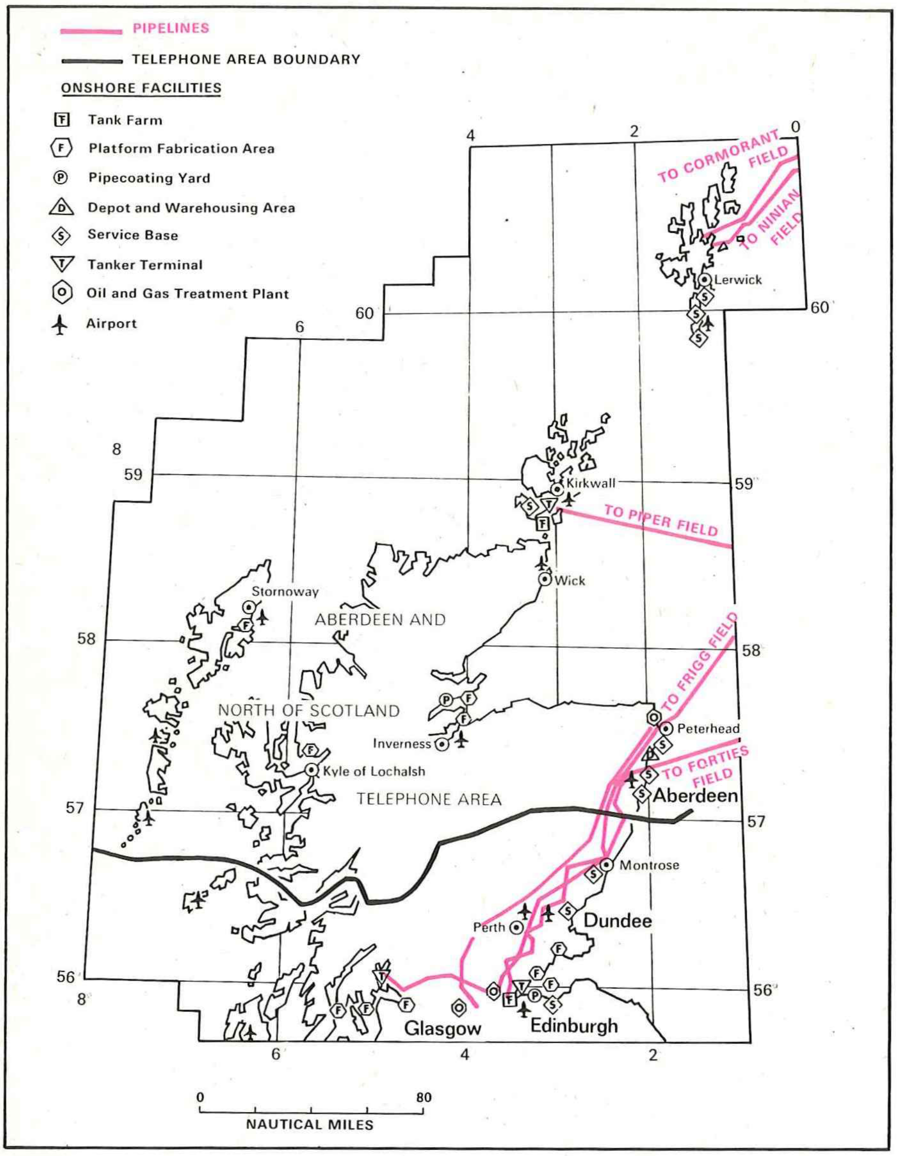
The difficulty, however, was to obtain firm details and to overcome commercial secrecy about the pace, scale and location of projected developments. It had to be decided which of the many applications for planning consents would result in actual projects – and when. Numerous plans fell ▶

**The upward trend in Aberdeen Telephone Area's telex connections.**




**Annual net increase in trunk and junction circuits provided in Aberdeen Telephone Area.**






by the wayside, either because consent was not forthcoming or financial backing could not be found. Wrong decisions could have resulted in abortive expenditure on a considerable scale, yet the Post Office could not afford to be found lacking when schemes went ahead.

The planning strategy we adopted was aimed, with customary Aberdonian caution, at minimising the risk of abortive capital development while giving ourselves a good chance of meeting energy-related demands. Fortunately, the longer lead time operations are those involving the least risk and the Area limited speculative expenditure in the main to group switching centre (GSC) buildings and equipment; trunk outlets from the GSCs; and junction cables from the local exchange to the GSC where this was justified by long-term forecasts.

In other words, it was decided to advance expenditure which could, if a project failed to materialise, be used eventually for normal growth.

Unforeseen requirements were catered for by ordering about £100,000 worth of small exchanges and associated grade of service equipment which could be used as and when required. For local lines, planning effort was sometimes committed but execution of the work held back until the project became firm.

In the larger centres, the problems arose not so much from individual projects as from very rapid general growth. Some GSCs, for example, experienced phases when trunk call growth rates were running at over 40 per cent a year and the strain on switching and circuit capacity was severe. Trunk traffic growth over the Area as a whole touched a peak of 22 per cent a year and has now settled down to 16 to 17 per cent (current UK figure seven per cent). Trunk calls handled have increased from 15 million in 1970/71 to 30 million in 1974/75. In meeting this growth, the modern cable and radio links provided for the Highlands and Islands scheme saved what in some cases would have been an impossible situation.

International call traffic has grown significantly – for example, 400 to 500 calls a day in Aberdeen compared with 50 a day previously – and the calls tend to be of long duration. International subscriber dialling for Aberdeen was hurriedly brought forward for installation by direct labour.

An incident which illustrates the dedication and ingenuity displayed by staff at all levels concerns an oil service base at Peterhead employing a large labour force of Italians. Calls to Italy became frequent and the officer in charge of the auto-manual exchange sought advice about Italian phrases for operators to help the calls through. This piece of initiative brought its own troubles, because on hearing snatches of their own tongue, callers would lapse into a torrent of Italian!

Expedient measures of all kinds had to be adopted to deal with the upsurge in call traffic and the escalation in demand for telephones, and planning and construction staffs with the help and backing of their colleagues at Scottish Telecommunications Board Headquarters, displayed considerable enterprise in overcoming difficulties. Manual exchanges, long overdue for replacement, were extended in unorthodox ways in any accommodation which could be made available. Pressures on the manual switchboard at Lerwick were so great that, even after full extension, control of trunk calls had to be transferred to Aberdeen.

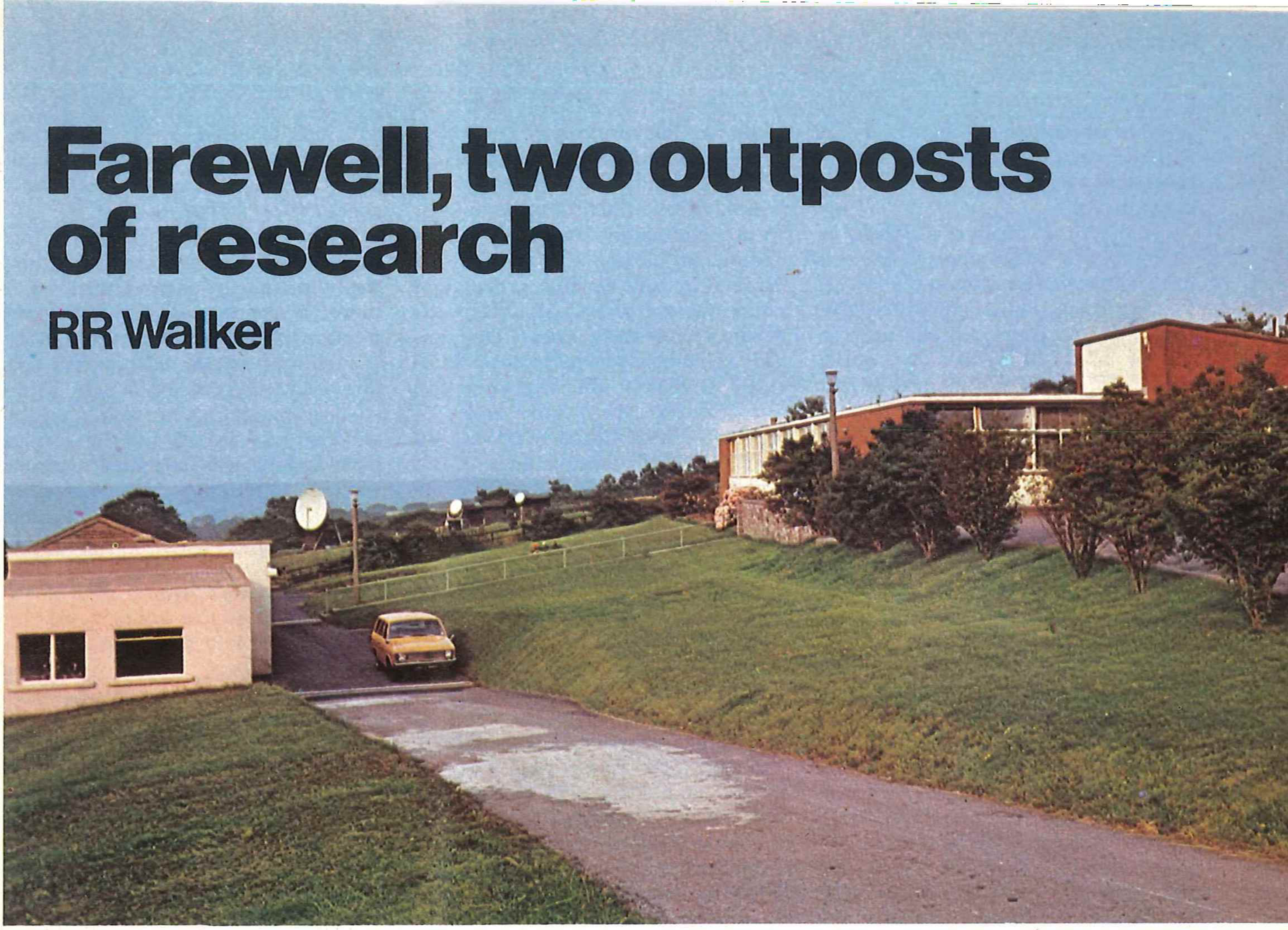
Several unit automatic exchanges (UAXs) have been extended up to 900 lines by the introduction of second selectors. Dyce UI3 was extended to 1,300 lines by the use of second selectors and two mobile automatic exchange units. One of the extended UAXs which was later replaced by a TXE2 electronic exchange has had to be re-opened under a different name to deal with growth until the new TXE2 exchange can itself be extended.

Mobile exchanges and transportable racks are being used on a considerable scale and about 9,000 subscribers are being given service by these means. Aberdeen has come under great pressure and its previous five to six mile commuting belt now extends to all towns and villages within a 30 mile range. Two years ago the city had three satellite non-director exchanges and one major non-director exchange which was also a trunk and group switching centre and housed a telex

**Continued on page 33**

# Farewell, two outposts of research

RR Walker



THIS SUMMER the sun will set a little earlier on the Post Office Research Department. Its outstations at Backwell near Bristol, and Castleton near Cardiff, have closed after more than 30 years following the decision to concentrate all research effort at the new centre at Martlesham Heath, Suffolk.

The passing of these two sites where much valuable radio research work was undertaken over the years, has not gone unmourned. From the time the first huts were erected in the 1930s to the present time when the accommodation had become much more comfortable, staff and visitors alike have been invariably captivated by the informal atmosphere that was a hallmark of both sites.

Informal it may have been, but there was never a hint of casualness. Soon after the sites had been taken over the war came and with it a policy of dispersal of important work. As a result, in late 1940 12 staff were moved down from London to Backwell under Mr D. A. Thorn and another dozen went to Castleton under Mr J. H. H. Merriman, now Post Office Board Member for Technology and Telecommunications Senior Director, Development.

A similar number were sent to a small research site at Banbury which was wound down at the end of the war. And it was in this comparative calm of the countryside that despite the somewhat primitive conditions and general discomforts of those years of austerity, a great deal of important experimental radio work was carried out. Some of this is shrouded in secrecy even now but it included radio direction finding and interference measurements. The fairly new technique of frequency modulation was also investigated.

When the war ended work began on a radio-relay system for the transmission of television signals and this led to the establishment in 1949 of a link with five hops from London to Castleton which was subsequently used to bring a television service to Wales for the first time.

There seems to have been an air of war time secrecy about this work too, because there was consternation all round when a Sunday newspaper published a front page story in 1947 which began with "exclusive revelations" that Britain was about to make a sensational gamble in television! It said that the gamble was based on the idea of John Logie Baird for a new relay system by which programmes would hedgehop on a coast-to-coast network by means of a wireless beam instead of a cable.

The article also contained this gem: "So considerate is the Government of ▶

**Above: Research Department's outstation at Backwell, near Bristol.**

**Below: In the clean room at Castleton used for the production of thin-film microwave circuits Mr A. K. Thomas employs a gold plating technique to increase the thickness of a pattern made by evaporation.**

possible objections of country lovers (to the repeater stations) that even the insulators on the aerials are to be coloured green!"

It is a fact that much of the basic design work for later radio systems was done at these outstations and a test set for frequency division multiplex systems that was developed at Castleton is now used throughout the world. This White Noise test set as it is now known, takes its name from the uniform type of noise used as a measuring signal; it is analogous to white light. By a happy accident the people in charge of the development were Messrs R. W. White and J. S. Whyte who is now Director of Purchasing and Supply Department.

It is, of course, impossible to mention the name Goonhilly without much reminiscing among the older staff of Backwell and Castleton. Both outstations were heavily involved in the early tests with the satellites Telstar and Early Bird and long periods of detached duty were spent in Cornwall. This was real pioneering work and staff were proud to be involved.

More recently Backwell and Castleton have become synonymous with microwave integrated circuits and with radio-relay systems in which the repeaters are mounted on steel poles. This latter is the 19 GHz short-hop system for digital signals, a new concept in radio systems now undergoing feasibility trial at Martlesham.

Despite all the progress in the last 30 or so years it is probably still those early war days which remain clearest in the memories of the Backwell and Castleton veterans.

They began with an official instruction stating that officers likely to remain at the temporary station for the duration of the war could remove their families and the Department would pay the bare cost of removal of furniture, and fares for the family. A weekly allowance of not more than one guinea (£1.05) would be made to cover continuing liability for rent of accommodation in London.

Both sites were on high ground and access was via several hundred yards of unsurfaced farm track. The situation could be idyllic in summer but in winter it was a different story and everyone has their own story of encounters with the snow, mud and less than friendly farm animals.

During the war years the ranks of the staff varied with the time of day. In official hours Post Office authority took precedence but at other times the Inspector became the sergeant in charge of the Home Guard. Obviously a certain amount of tact was required at all times.

In 1946 when it was decided to make both stations permanent, the slow process of improving conditions on the sites began. Not everything moved as quickly as perhaps staff might have wished and in some cases things had to be done in the cheapest way only to be re-done properly a few years later.

Take the water supply at Castleton, for example. The site is five miles from the nearest town so water was required not only for sanitation and washing but also for drinking and cooking. In 1945 a high ranking member of the Engineer-in-Chief's Office wrote: "It is agreed that the contention that the rainwater collected from the roofs is unsuitable for drinking purposes must be accepted".

As a result a year later arrangements were made for water to be collected from Castleton Post Office a mile away on payment of five shillings (25p) per annum. By 1949 piped water had been laid on – not from the mains – but from the overflow of a spring-fed tank on a neighbouring farm. Eight years later this had dried up completely and after prolonged negotiations, mains water arrived in 1961.

By the early 1960s both sites had properly constructed accommodation and the staff at each reached 30 or more. Backwell and Castleton were pleasant places at which to work and the influx of official visitors from London used to increase markedly in the summer months. The view from the windows was superb and the distance from London was adequate to ensure virtual autonomy in day-to-day affairs. And, most important, relationships with the Regions in which they were situated were excellent.

Over the years turnover of staff was minimal and as the buildings became more civilised and the apparatus more sophisticated the work continued apace. Both Backwell and Castleton proved themselves highly efficient and many of the necessary support services such as drawing office, workshop and clerical assistance were readily available on site. Staff would also double up on jobs when necessary.

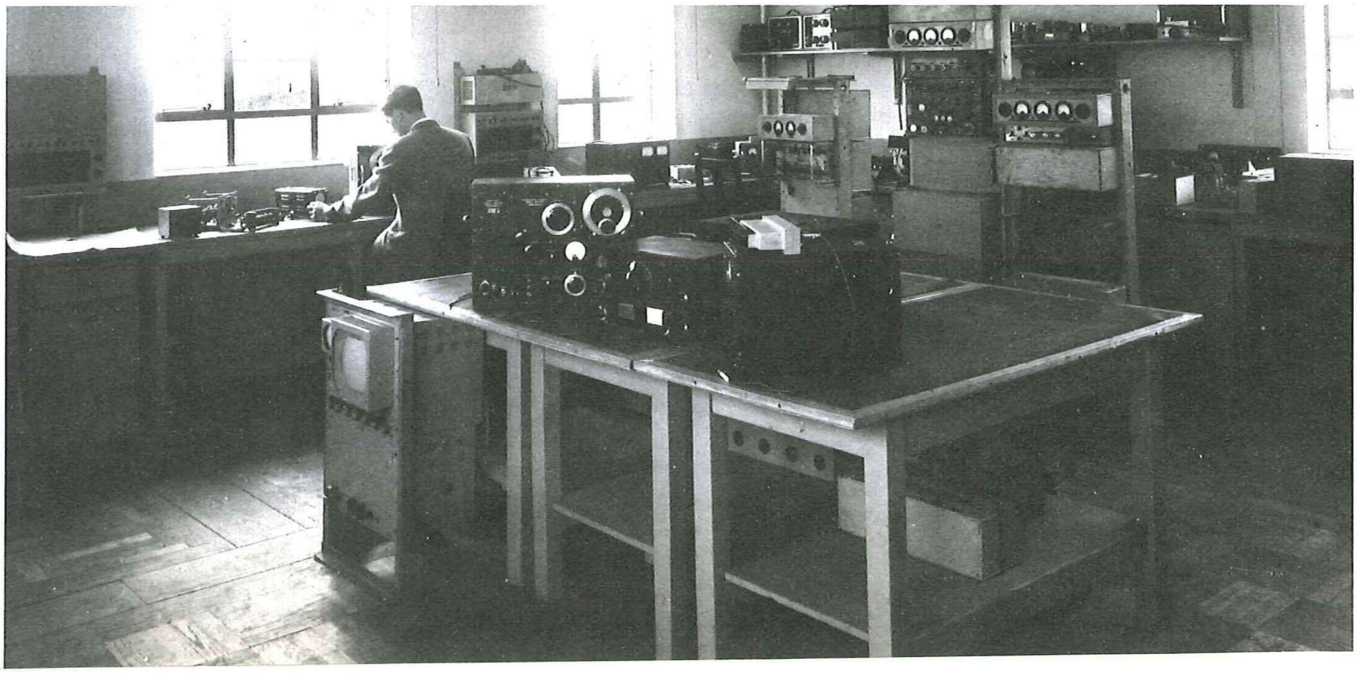
Inevitably, of course, despite the glow of nostalgia, there were some drawbacks. Small communities have limited opportunities for career advancement and there could be a feeling of isolation from the wider work of the Research Department.

Working at Backwell and Castleton was, however, a unique experience and the names of these two places will always be remembered with affection by the 230 people who over the years spent part of their careers there.

**Mr R. R. Walker** is head of a section in Research Department at Martlesham responsible for the development of 19 GHz radio relay systems.

**Bygone days . . . one of the laboratories at Castleton, pictured in the early 1950s.**





BACK IN 1870 when the penny post was the envy of the world and the telephone was still an unrealised dream of Alexander Graham Bell, the Post Office took over its first two factories in Camden Town, London, and Bolton, Lancashire, employing 175 people on the manufacture and repair of telegraph equipment.

Since then the Post Office has undergone far reaching development and change and the scale of factory operations has developed out of all recognition. The two original factories have gone and there are now eight situated in London, Birmingham, South Wales and Edinburgh to repair, modify and refurbish all types of telecommunications equipment. In all about 1,800 jobs with an output value of more than £24 million a year are handled annually by 4,000 factories' staff. In short their activities have become a substantial industrial exercise.

Yet although the first balance sheet was introduced in 1902 it was not until 70 years later that the emphasis was changed from accounting for money spent to providing information for managing a business. And apart from changes in the detailed costing system the basic philosophy behind the running of the factories had remained unaltered since the First World War.

But 1972 saw a change. The decision was made to design a modern Cost Control and Responsibility Accounting System with main objectives of providing a system enabling management to control expenditure and measure the profitability of all activities. It also allowed measurement of managerial efficiency by comparison with predetermined costs and provided a means to guide Factories Division (FacD) operational policy.

At the same time it was important that the cost control system enabled local factory management to discover and correct errors in methods, facilities, manpower and organisation as well as securing lower costs and improving operating efficiency. It also needed to provide information for FacD Headquarters to control FacD business overall, to evaluate alternatives – such as make or buy – help decision making, and direct and co-ordinate long-term planning and development. This method of cost control, however, requires a system in which every cost must be charged to someone. The first steps therefore were to define areas of responsibility and to identify costs. Areas of responsibility were based on existing organisation structure and were set at three levels.

**Post Office management uses a modern accounting system to control expenditure and measure the profitability of all activities at its factories which repair, modify and refurbish telecommunications equipment.**

# Factories give a good account of themselves

## A C Newbold

The responsibility centre was defined as a major area of the organisation with a senior manager in control. A budget centre was set up as an organisational unit to carry out an identifiable production or service function with one manager responsible, and finally a cost centre – a subdivision of a budget centre – was introduced. Cost centres could be identified as places or groups of staff or machines.

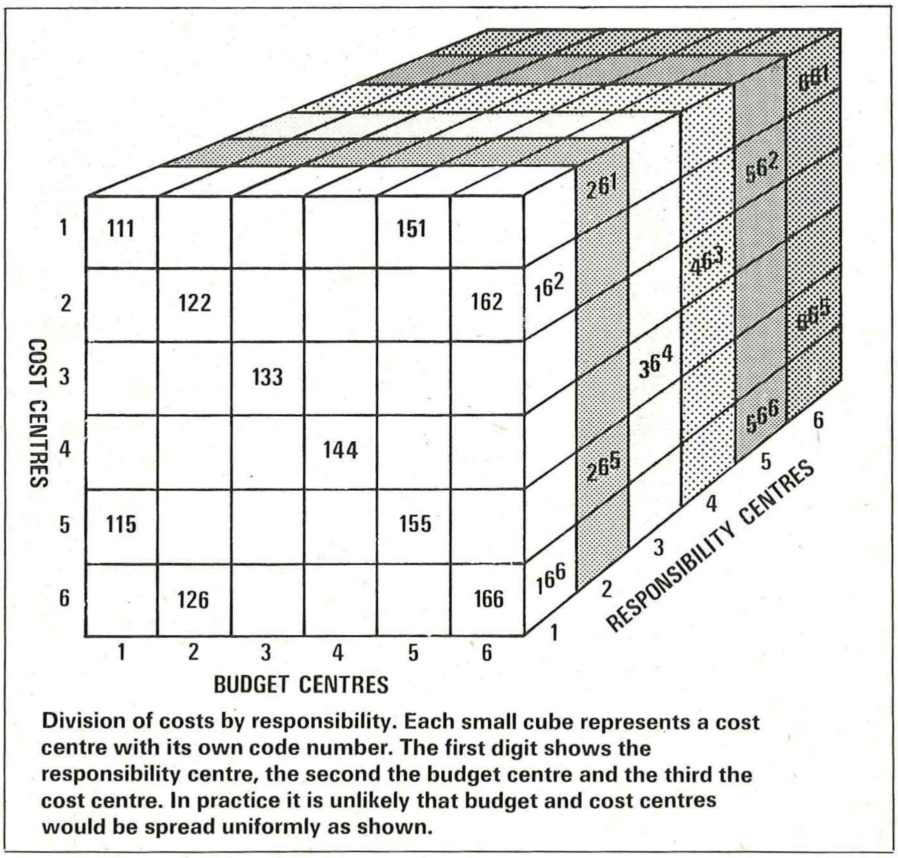
As a whole FacD was divided into six responsibility centres, each of which was broken down into budget and cost centres as appropriate. Next, each cost centre was given an individual three-digit code number, the first digit showing the responsibility centre to which it belongs, the second the budget centre and the third its own number within the budget centre.

Items of income and expense have also been allocated individual three-digit code numbers. The first digit relates to a primary analysis and the second and third to more detailed breakdowns within this analysis.

Thus all accounting documents in FacD, including payroll, are now identified by a six-digit code and a nominal ledger has been set up to record the information. Also a "double-entry" book keeping system has been introduced to reveal the amount of money spent, what it was spent on and who was responsible for the expense.

So far the system does no more than identify costs and assign the responsibility for them. But as the fundamental purpose of FacD is to get items of the right quality out of the factory at the right time and at the right cost, it is obvious that cost alone is only one of the elements in providing customer satisfaction. The new system therefore needs to be integrated with other control systems to be properly effective.

To achieve this there must be planning to control expenditure in such a ▶




**Division of costs by responsibility. Each small cube represents a cost centre with its own code number. The first digit shows the responsibility centre, the second the budget centre and the third the cost centre. In practice it is unlikely that budget and cost centres would be spread uniformly as shown.**

way that it will give the best chance of achieving a set target. And this in fact, is what budgetary control is all about.

For production control purposes the budget year is divided into 13 four-week periods. The budgeting process begins in the October before the budget year (that is April to March) when details of most production commitments are known. A production plan is drawn up and published together with other forecasts which may be relevant, such as the amount of overtime or capital expenditure. This then enables each responsibility centre manager to prepare an operating plan.

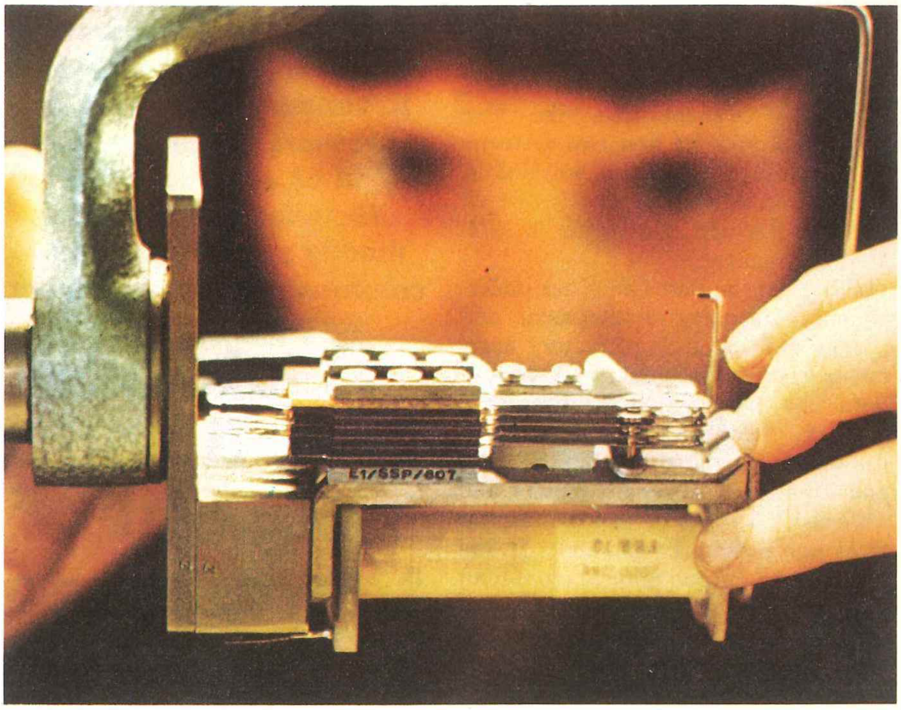
Each cost centre manager assesses the resources he will need to meet his part of the responsibility centre operating plan, making sure that every factor is taken into account. The resource budgets are then prepared for each four-week period and are converted into money and expense types by the Budgetary and Cost Control function, and agreed with the cost centre manager.

Groups of related cost centre budgets are built up to give a budget centre summary and budget centres are combined to give a responsibility centre budget. Finally the combination of the responsibility centres gives the Divisional Budget.

These then are the basic ingredients for control. At the end of each period, a set of operating and performance statements is prepared for each cost centre and summarised at budget centre, responsibility centre and Divisional level. This allows all levels of management to be quickly aware of performance in relation to the budgeted plan and they can easily see they are a part of the complex jigsaw that makes up the overall Divisional production plan.

Another plus factor is that if the actual expenditure differs from the budget, the variance can be traced and the reason for it analysed. There can be many reasons for variances, but whatever they are they indicate whether or not the production plan will be met in due time at the expected cost. If not the analysis gives early warning that corrective action needs to be taken.

It will of course, take some time for FacD to become experts in this detailed type of budgeting but in the meantime other changes to aid control are taking place. There will, for instance, be a stores control ledger to show by production period, the cost of materials purchased and issued at Factory Catalogue value – a price list of parts stocked by FacD – and there will be a ledger recording price variance where items are bought at a rate other than that shown in the catalogue.



**Trainee technicians familiarise themselves with the wide range of work undertaken at the eight Post Office factories in London, Birmingham, Edinburgh and South Wales.**

Also the value of stock holding and of materials in work-in-progress will be known at any time. And apart from giving a measure of control, and being able to obtain regular feedback on stock levels and prices paid, stores control ledgers will ease considerably the tedious work of annual valuation and stocktaking.

The complex task of designing and introducing new production control procedures in FacD is also under way. This will be a major task but its aims include the stabilising and regularising of job size and length, and materials procurement and usage. The new procedures will key in with the accounting system in measuring and coding input to production, and finished goods as they are approved.

Thus the way will be paved for improved job costing and the introduction of product cost control by standard costing methods, which will quickly disclose variances arising between forecast and actual costs of individual products so that early decisions on the economic viability of competing products and resources will be possible.

These management information systems will result in the accumulation of a considerable bank of data, which will be indispensible in setting future plans and budgets. The data will be processed by electronic accounting machines which are already being installed to handle the FacD payroll.

**Mr A. C. Newbold** is head of a group working on special studies in Factories Division of Post Office Purchasing and Supply Department.

# Working from home-
## a long range view/J Glover

**Experts' views on the uses of advanced telecommunications in the coming decades suggest there will be a large number of home-based employees. This article, summarising Post Office long range forecasts, draws tentative conclusions about working from home and its effect on Post Office planning.**

**Everyday scenes in the life of city commuters. But telecommunications technology could lead to a steady increase in home-based employees.**

OFFER ANY travel weary commuter the chance of working from home and he would probably jump at it. Or would he? A recent investigation by the Long Range Studies Division at Telecommunications Headquarters suggests that although advanced telecommunications equipment such as facsimile, the viewphone, teleconferencing and so on could make the daily trip to the office unnecessary, some people would still be prepared to put up with the discomforts of travelling for the social contact of working with others.

The study, one of several made by various organisations in recent years, also concludes that any such change in the work pattern would be sufficiently gradual not to have a significant effect on current planning in the Post Office.

The potential of advanced telecommunications has inspired some writers to predict widespread working from home by the end of this century. In ▶

one study by the Institute for the Future in California more than 200 experts in different fields concluded that American executives would work from their homes by 1990. In another study it was suggested that some clerical workers would be home based by the late 1970s and that by the 1980s numerous people would work from home at least some of the time.

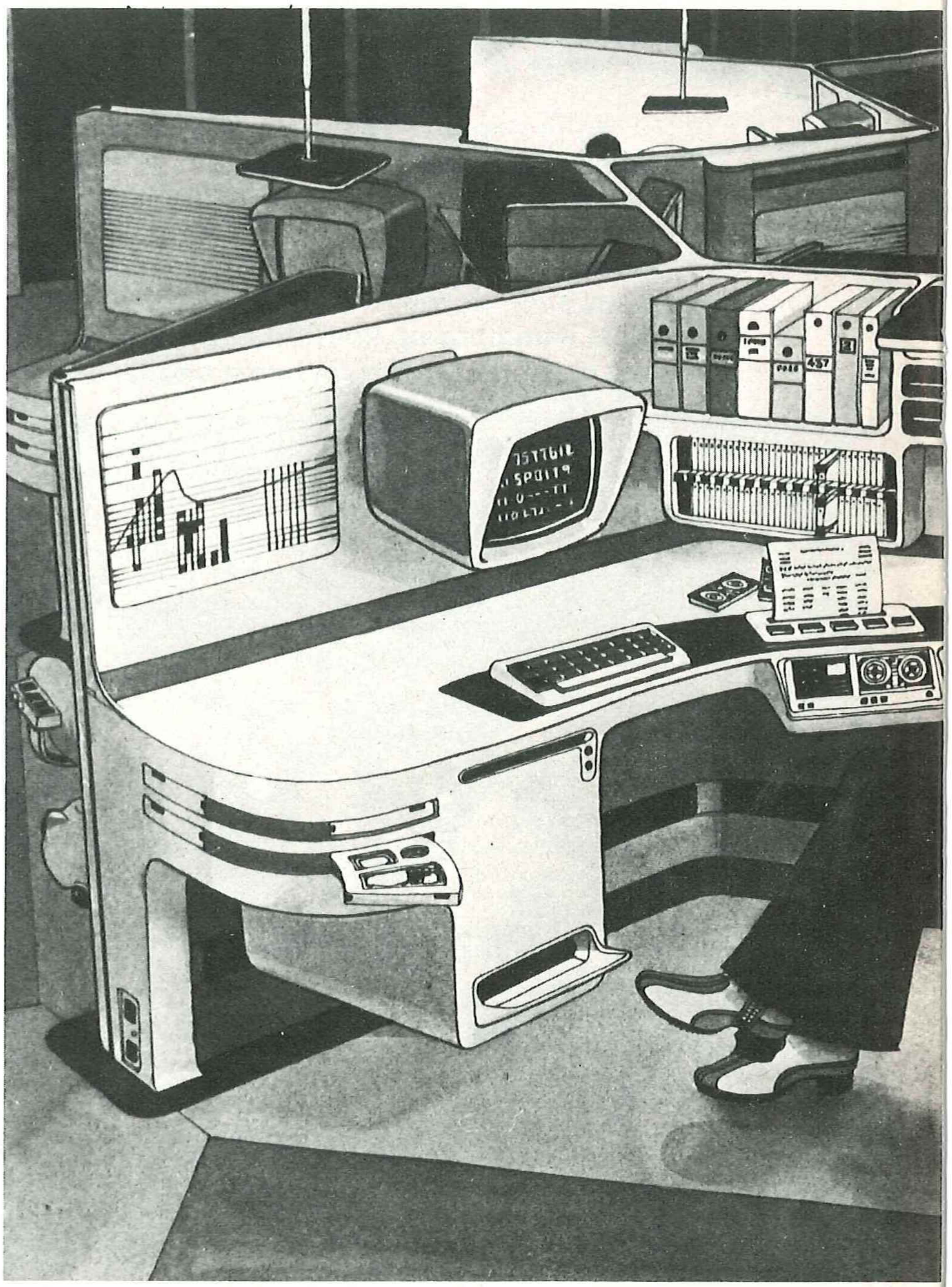
But working at home is, of course, not a new phenomenon. Only two centuries ago most people worked at or from their homes. Then came the Industrial Revolution, people moved to the cities, and the seeds of our modern, industrial way of life were sown. Some writers are suggesting now that telecommunications technology could completely reverse this process.

There are, of course, many good reasons for working from home apart from avoiding the strain and expense of the journey to and from work. Firms could reap the advantages of lower rents and overheads and it has been suggested that a flagging will to work could be invigorated. Energy could also be saved, pollution diminished and at least two prophets foretell the demise of the city and the revitalisation of declining rural areas if more people were to work from home taking full advantage of communications.

There are at least two substantive studies which add weight to these views. At Stanford University in California, information from a government classification of occupational tasks was used to establish the number of "Information Processors" in the labour force. "Information Processors" are people whose jobs involve transmitting information in written or spoken form rather than using machinery or providing services such as hairdressing or surgery.

The study concluded that in a large area around San Francisco no less than 22 per cent of the work force could work from home now. And it is a trend in all the highly developed countries that both the proportion and number of "Information Processors" in the work force is increasing. The changing occupational structure in the UK can be seen from a recent Cambridge University study.

If jobs are broadly classified into the Primary Group (mining, farming fishing), the Secondary Group (manufacturing) and the Tertiary Group (services) the latest group acts as an indicator of the growth of information processing occupations. Consider this illustration:



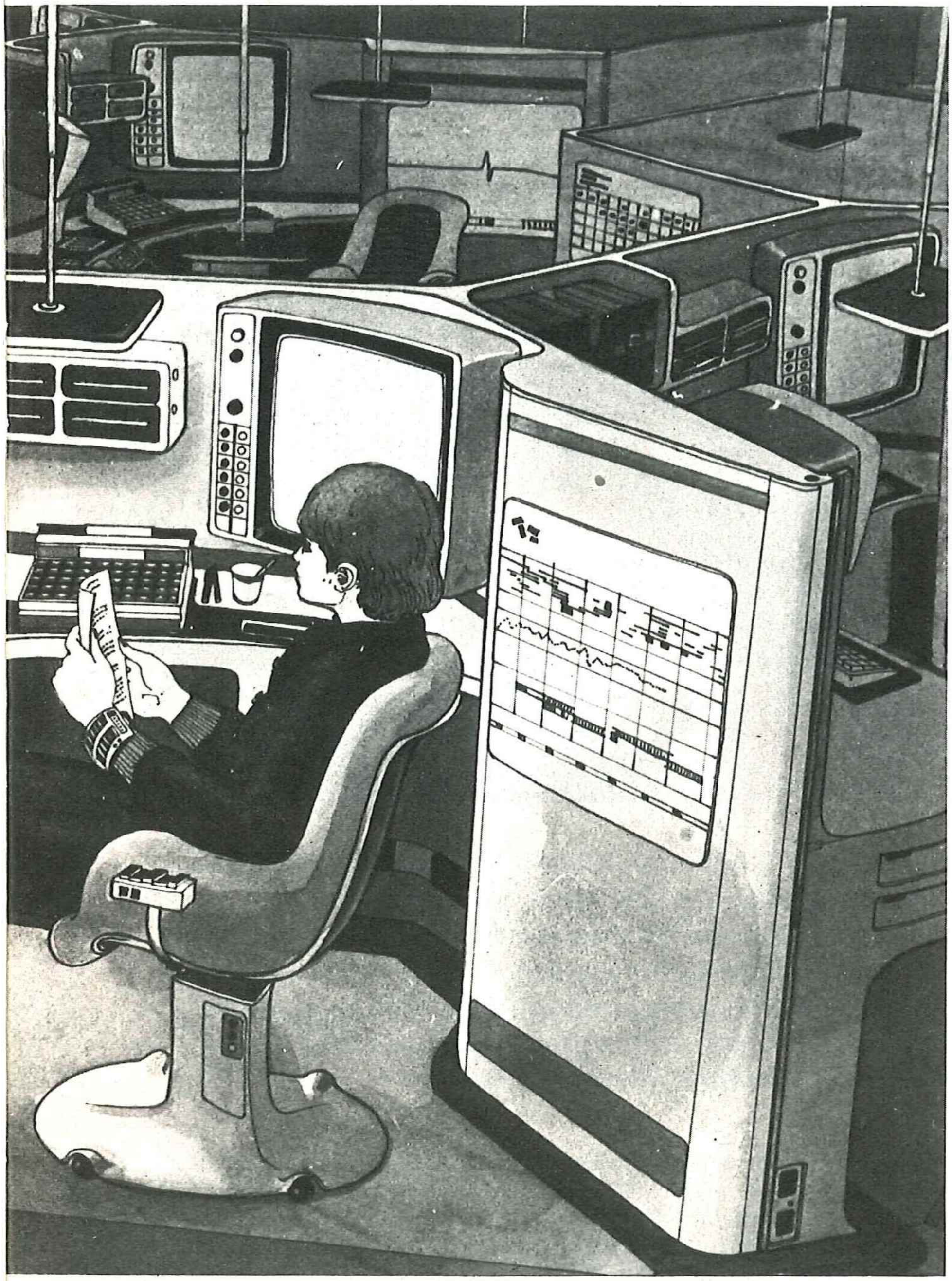
**Tomorrow's office? An artist's impression of how, in about 20 years' time, a young executive might go about his business either at home or perhaps from a neighbourhood work centre. His work cell includes a visual display unit, desk communicator, viewphone, microfilm files of company records, colour copier, dictation dispatcher and refreshment dispenser.**

| | 1951 % | 1961 % | 1971 % | 1981 % | 1991 % | 2001 % |
|---|---|---|---|---|---|---|
| Primary | 8.8 | 5.9 | 3.4 | 3.0 | 1.8 | 1.1 |
| Secondary | 53.0 | 47.6 | 45.7 | 39.4 | 34.6 | 29.5 |
| Tertiary | 38.2 | 46.5 | 50.9 | 57.6 | 63.7 | 69.3 |

The assumptions on which the Stanford study are based may be conservative but even so if the figure of 22 per cent is about right it means that almost six million people could work from home now in the United Kingdom.

The second study which adds further credibility was conducted by the Communications Studies Group at University College, London. More than 6,000 civil servants completed records of their meetings and over 2,000 took part in laboratory experiments holding different types of meetings over a variety of media. The broad conclusions to emerge were that currently available forms of telecommunications could provide effective substitutes for face-to-face meetings if the meetings were characterised by the exchange of information, co-operative problem solving, or routine decision making.

But for meetings characterised by bargaining or the development or maintenance of personal relations, although visual telecommunications



are better than audio they still fall short of face-to-face meetings.

Despite all this, however, these studies only deal with some of the issues involved. The psycho-social implications warrant more attention and it was from this standpoint that the Post Office study was undertaken.

The first major step was to review the existing relevant work throughout the world drawing on as much social science research as possible. Since few of the studies were directly concerned with working from home, the relevance of the concepts were briefly tested in seven interviews with people who currently work from home, including a computer programmer, the secretary to members of Parliament and the managing director of a firm employing more than 350 home-based computer programmers and systems analysts.

Results indicated that working from home could lead to a reduction in job satisfaction for people who put high value on mixing with others. Indeed, one of the problems mentioned in six of the interviews was isolation – from ideas as well as social contact. Although there is little doubt that advanced telecommunications systems will alleviate this problem in the future it is suspected that it is informal contact which will be most difficult to establish remotely and that it is this which contributes to the job satisfaction of many people.

In research on the relationship between work and leisure, it was discovered that work is a "central life interest" for a minority of people, for them there is no marked distinction between work and leisure, and work colleagues are also friends. For most people, however, leisure activities and friends have little connection with work. For people who do not make a marked distinction between work and leisure, working from home would seem to be an appealing idea.

In the study, time was also spent on examining work from home from the company's point of view. Most companies are organised in a pyramidal structure in which people at one level are supervised by those at the level above. Obviously, if employees were at separate locations the control of output and performance would be more difficult to maintain.

In the firm employing more than 350 home-based computer programmers, strict regular reporting procedures have been established to ensure that work is completed on time. An alternative suggestion is that an automatic device would monitor the time an employee sits at his desk in the home.

This suggests that companies considering home based working may be tempted to introduce a strict supervisory style to compensate for the control being forfeited. Today, however, with the trend towards less supervision generally – flexible working hours is a step in this direction – such moves as automatic monitoring in the home would probably make working there unacceptable.

To sum up it seems at present that although there are many complex issues raised, a steady increase in the proportion of home based employees could take place, particularly among writers, academics, researchers and computer personnel, and there is a good chance, too, that more women with young families could make use of specified telecommunications services designed to overcome separation from the office.

The services could include, for instance, the setting up of specially equipped neighbourhood work centres. Demand is likely to be stimulated as the potential of new telecommunications devices are publicised and to meet this the Post Office must be prepared to adopt the very flexible and specialist marketing approach which will be required.

**Ms J. Glover** is head of the Sociological Studies Section in Long Range Intelligence Division at Telecommunications Headquarters.

# CONSTRUCTION ENGINEERING DEVELOPMENT IN JAPAN

**James Brown, a Technical Officer in Edinburgh Telephone Area, describes here the setting up of a telecommunications development centre in Japan to specialise in external plant construction techniques. Following a successful Churchill Travelling Fellowship trip to the country – featured in our Summer 1974 issue – Mr Brown made a return visit at the invitation of Japan's telecommunications administration, and with support from the Post Office and the Winston Churchill Memorial Trust.**

THE NIPPON Telegraph and Telephone Public Corporation (NTT), which operates Japan's domestic services, is also largely responsible for all new telecommunications developments and techniques introduced in the country. Its head office structure contains three electrical communications laboratories where research and development activities embrace a wide technological field.

The main areas of investigation by these laboratories include switching systems, visual communications, customers' equipment, data communications and processing and electronic equipment. They also cover transmission systems, component parts and materials and outside plant. While considerable advances have been made, external construction work has become steadily more difficult in the face of such problems as increasing road traffic, noise prevention regulations, and growing activity in building and work on essential services.

With the aim of improving the construction engineering of its outside plant, NTT therefore decided to set up a new development centre where problems could be thoroughly investigated. The centre was established in 1972 on a 22 hectare site (about 55 acres) at Tsukuba New Town, 60 km north-east of Tokyo.

This large new complex of buildings and test areas has been designed to simulate conditions on working sites. It is hoped that by testing and developing new and modified equipment, machinery and methods in this way any teething troubles and field problems will be resolved before actual site work starts.

The centre is not yet fully operational, but already a large number of experiments and research projects are being undertaken there by about 100 engineers. Eventually, NTT's Outside Plant Engineering, Underground Facilities Engineering, General Management and General Affairs Divisions will all operate research and development programmes at the complex.

In addition to these activities, it is intended to train field engineers at the centre, to familiarise them with construction engineering methods under working conditions. Trainees will also be given tuition on the use of different types of construction machinery, such as automatic tunnelling and boring equipment and machinery for erecting poles and laying cables. Hostel-type accommodation is being provided for all trainees, and by 1976 the training programme is expected to total about 20,000 man-days.

The site comprises three separate sections. Section A, for example, has a large open-air water tank for testing the water tightness of various line equipments and for experiments on methods of laying cables on the sea bed. The 50 m long, 5 m wide and 5 m deep tank is fitted with a glass side to aid observation of tests from a wide passage alongside the tank.

Another main feature of the Section is a 150 m long "weather room" where cable laying and jointing methods can be examined under different temperature conditions. The room temperature can be lowered or raised as required and water is provided by a built-in sprinkler system. Experiments can be monitored in a separate control room at one end of the building by means of closed-circuit television from cameras fitted in the "weather room".

Power distribution equipment and a hangar which provides accommodation for various large-scale experiments complete the present facilities of Section A. However, work is in progress on an experimental tower which will be used to examine vertical cable distribution systems for high buildings. Other accommodation is being provided in the Section for experiments on underground structures in different kinds of soil, to study the corrosive effects of soils and to test the efficiency of construction equipment. The effect of road traffic on underground cables and other structures in typical soils will also be examined.

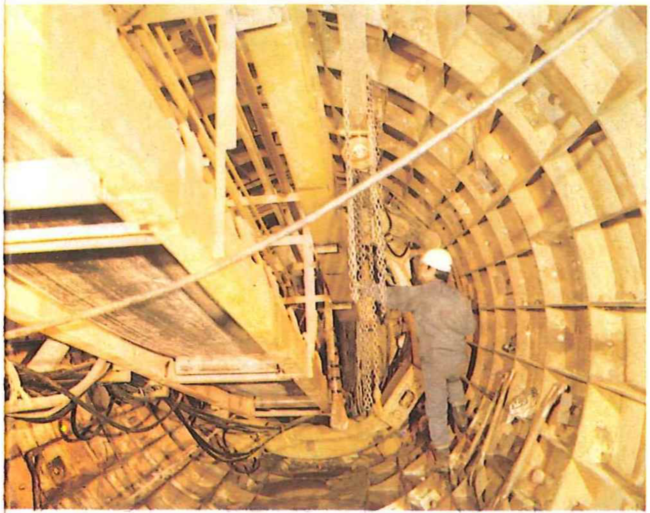
The wide range of experimental buildings currently provided in Section B includes a laboratory for the study of materials used in experiments in the outside test areas. For example, the laboratory will examine how much a cable is weakened by bending and stretching, and the breaking points of wires and cables. A soil testing room will be used to carry out detailed breakdowns of soils and their different effects on underground plant, while a cable testing room has been provided to study the effects of corrosion on cables and methods of jointing.

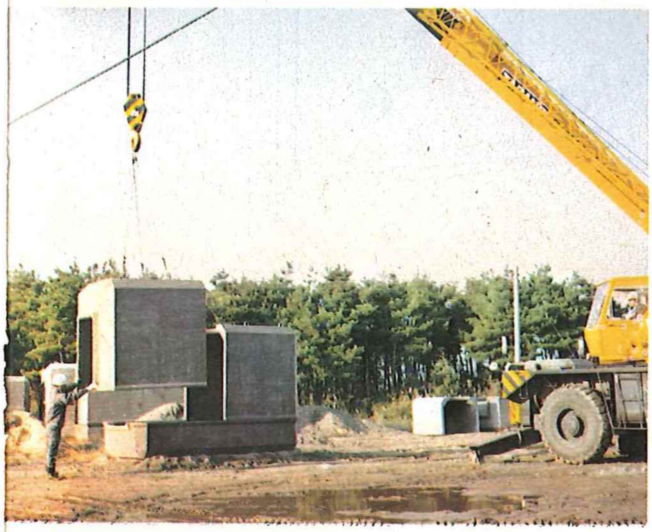
Work is also in progress to provide a management and research building in Section B which will house staff offices, laboratories, training rooms and a library. A special experimental building will also be provided in this Section for examining the strength of full-size structures, such as tunnels and large manholes. This building will be able to withstand a load of about 2,000 tons on the floor or suspended from the roof.

The third Section of the centre has been designed mainly for outdoor research and development. It includes a test field for newly-developed digging and tunnelling machines, and a transmission line testing ground where experiments can be carried out on methods of laying and studying the electrical characteristics of transmission line cables.

There is also a test area, complete with lighting and water sprinklers to simulate actual working conditions in the construction of outside plant, to study problems caused by earthquakes and means of quakeproofing duct lines, manholes and tunnels. In this Section, too, staff will be trained in the operation of equipment and heavy machinery.

One of the main themes of develop- ▶





**Opposite: The site of the Telecommunications Construction Engineering Development Centre at Tsukuba, Japan.**

**Left: A cable tunnel is constructed by the shield method, using a machine which is controlled from the tunnel face.**

**Left centre: Pre-cast concrete manholes under development at the Tsukuba centre.**

**Below: Trials are carried out with a cable lifting vehicle which dispenses and lashes the cable to a suspension wire.**

**Below right: The 50 m long water tank at Tsukuba, which can be used to test the water tightness of line equipment and for methods of laying submarine cables.**

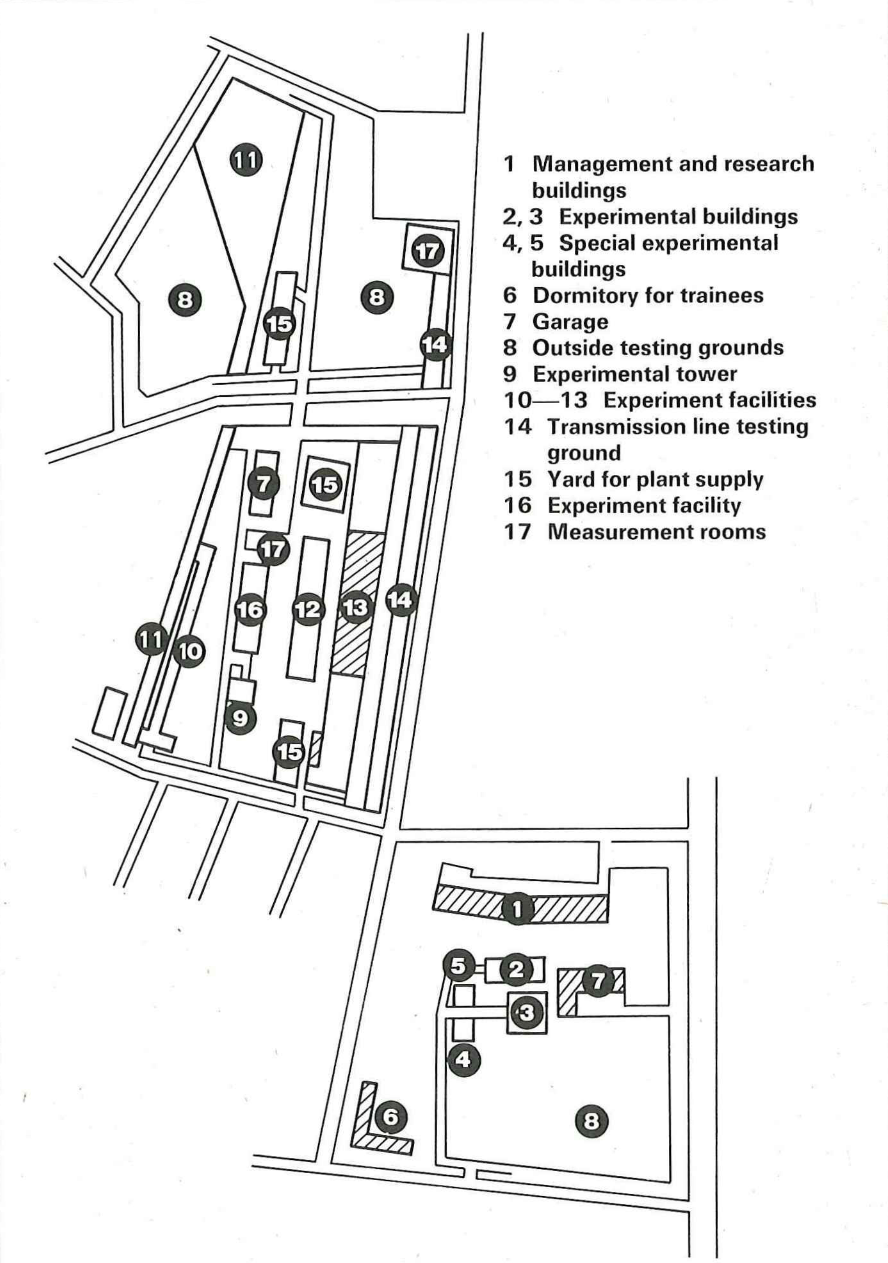
ment currently being pursued at the centre is construction engineering for new systems, such as millimetric wave-guide transmission. Others are aimed at reducing considerably the time and labour required to complete projects, accident prevention and new methods of construction both to meet the changing city structure resulting from building and development programmes and to take account of environmental needs in urban areas.

Research, for example, is in progress to simplify, and save labour in the erection of aerial cables. More than 85 per cent of local network distribution is by overhead means because Japan suffers from two natural phenomena – earthquakes and rainy seasons – which can adversely affect underground plant. To rationalise overhead construction, therefore, a multi-cable suspension method is being developed in which three cables are suspended and then bound together by wire. An automatic cable-lifting vehicle is also under development which can dispense and lash cable to a suspension wire as the vehicle moves between two distribution poles.

Another project aimed at reducing on-site construction time is a method of steam curing concrete manholes. In this method the concrete is poured into moulds forming the manhole and then steam blasted to harden it quickly without the need to use additives for quick setting which may weaken the structure. The structure, specifications and jointing methods for smaller manholes of the pre-cast concrete type are also being studied in an effort to find ways of saving time and labour required in their construction.

Growing demand for telephones in Japanese cities is leading to an increase in the need for tunnel workings. At present construction by the shield method – in which short lengths of tunnel are excavated and then lined with steel sections to form the complete circumference – is carried out by hand. The centre is now examining new, faster and safer shield methods by which most excavation and direction control can be done mechanically and automatically.

Machines for different tunnel diameters have been built to dig the tunnel by circular boring methods and to place the outer shields in sections which bolt together as the machines move forward. One type of machine currently in use for large tunnels about 10 ft high, which carry inter-exchange connections, is controlled from the tunnel face. A second, mini-machine for small excavations of 3 ft - 10 ft diameter is operated from a control room at road level with the aid of closed-circuit television linked to a camera mounted on the machine.




Plan of the Tsukuba Engineering Development Centre

Research is also being carried out on a cable-laying machine which can bury cable directly into the ground in apartment housing areas. A tractor-towed surface cutter parts the soil to a depth of about $1\frac{1}{2}$ ft and automatically feeds in cable from a drum mounted at the rear of the plough.

Pole erection techniques in which one vehicle carries a pole to the site, bores a hole and erects the pole, an hydraulic method of excavation and soil improvement by the use of chemical grouting are among the other developments being actively pursued at the centre. Another important line of investigation involves the measurement of noise generated by the introduction of heavy construction equipment, which may require countermeasures to avoid public nuisance.

The work mentioned here, in fact, gives only a broad picture of the many projects and developments being undertaken and planned at the centre. NTT hopes that by setting up this complex to concentrate on the many problems arising in construction work that both its staff and the public will benefit from more efficient, economical and safer methods of telecommunications construction engineering throughout Japan.

PO Telecommunications Journal, Summer 1975

# The value of analysis

## CM Halliday

**Savings totalling about £10 million have been achieved to date by a specialist team in Post Office Telecommunications which studies the cost effectiveness of equipment and operational requirements.**

IN THESE days of soaring costs and rapidly rising prices it is more important than ever that a major business like Post Office Telecommunications should get value for money in all its dealings. But how best can this be achieved?

It is often said that a customer only gets what he pays for, but more accurately he pays for what is specified – and this is where Value Analysis comes in. Value Analysis can be defined as "a disciplined approach to specify correctly the functional requirements of a product eliminating unnecessary costs without loss of performance". Its application as a management technique first emerged in the United States of America towards the end of the last war. In the early 1950s it was introduced into this country and has been developing ever since.

Members of a Value Analysis team in action discussing a main distribution frame terminating unit.

The principles are relatively simple to understand but achieving results is more difficult. In the Post Office, a system of Value Analysis has been operating successfully for seven years.

By last year record savings of almost £4 million were being achieved from studies already completed by the 20-man team whose brief is to look at cost effectiveness across the entire field of telecommunications equipment and working methods. So far total savings attributable to the Value Analysis Division since it was set up are now around the £10 million mark.

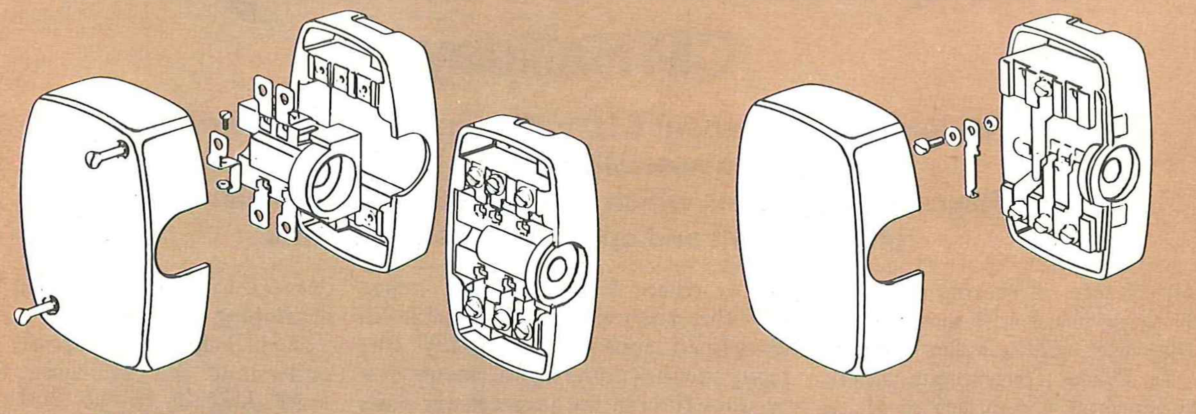
The savings achieved are, in fact, playing an increasingly important role in maintaining the efficiency of Britain's telephone service as well as helping hold down prices for the customer. Results on this scale are achieved by close scrutiny of selected designs ranging from private branch exchanges to pallets and from cables to labels.

The VA team examines critically the functions of a piece of equipment, or a component as well as considering the expected life cycles, capital, installation, operating, maintenance and repair costs. It then seeks new ways of carrying out the function to get maximum value for money.

The savings produced come from paying less for modified designs and from improvements that will reduce running costs. They also stem from economies in time and space yielded by increases in productivity, or from a reduction in accommodation needs.

A recent study of the 50-circuit units that join customers' lines to the main frame in telephone exchanges, for instance, has led to the developing of a newly designed unit with a capacity of 100 lines. Used nationwide this is expected to save space, capital and planning, valued at £1 million a year.

Other recent examples of savings brought about by the work of VA teams show the extent of savings involved. ▶



**Original Designs**
**Screw-on cover.**
Separate base and body mouldings (different body moulding for each jack).
Mixture of phosphor bronze and nickel silver springs of complex shape.
Springs secured to body moulding with screws and nuts.

**After Value Analysis**
**Snap-on cover.**
Integral base and body moulding to suit both jacks.
All springs of nickel silver and of simplified shape.
Springs staked into base body moulding.

**Jacks used with plug and socket telephone arrangement (Plan 4)**

Substituting a thin nylon skin for the braided sheath on jumper wire for telephone exchanges and using thinner wire saved £1.3 million. A joint analysis with a teleprinter manufacturer produced more than 60 modifications and saved £200,000, while eliminating the smaller power units for manual switchboards, thus avoiding a change to larger units when the switchboards are extended or replaced, saved no less than £380,000.

The Division itself is organised into five study groups each looking at a specialist field of activity and headed by a group leader. These groups cover customer apparatus, exchange systems, transmission systems, external plant and miscellaneous studies and are associated with and supported by three other groups responsible for audit of specifications, materials and production processes, variety control and contractors' variants together with a training function.

Value Analysis is, of course, a team business and the work is not done in isolation by the Division. When a preliminary survey of a product indicates that it is worth studying for potential savings, experts from other departments are called in to join the VA team with VA Division's engineer acting as chairman.

A typical team comprises between six and eight people and includes representatives from divisions in Technical Development, Service, Marketing, Contracts, Telecommunications Management Services and in some cases a Regional member. In this way all parties are represented and their particular interests are fully considered in the final analysis.

The principles of VA are based on five distinct stages beginning with INFORMATION. Before the first meeting of the team VA Division will have collected all the facts about the item to be studied. This includes specifications, drawings, manufacturing methods, quantities bought, issue recoveries and repairs, sources of supply, cost breakdown, installation and maintenance costs as well as life cycle and factory repair programme.

All these will be presented in documented form for discussion at the first meeting. Team members are then likely to highlight service difficulties or work study information which has been more recently obtained. Next they may look at the marketing strategy which could be changing or the design engineer may perhaps be aware of possible improvements as the product could have been designed several years previously.

In addition, new materials may have been introduced, advances in technology may have taken place and it is possible too, that there may have been a change in the economic pattern of the overall system costs.

The VA team therefore, provides a forum for full analysis and an opportunity to establish the relationship of function to cost. The chairman guides the discussions to ensure purposeful and effective conclusions.

Next the team moves into the second, and probably most exhilarating stage – SPECULATION. At this point no holds are barred and the team becomes involved in a brainstorming exercise generating new ideas and alternative ways of providing for an item's function. Costs are not considered at this stage and all suggestions are carefully noted. An outlandish idea of one member for instance, may trigger someone else to come up with a better and more practical suggestion.

The chairman may also act as a catalyst in directing new trains of thought as well as restraining any criticism of the creative ability and initiative of other team members. It is by this process that new solutions emerge.

Third comes the EVALUATION stage where the alternatives developed in the previous phase are subjected to a test of their economic feasibility. Each alternative is costed and placed in order and then the team analyses the practicability of each proposal – beginning with the one which promises the greatest savings – to determine whether that alternative is technically sound. This process continues until the team agrees on the best solution. To

help them reach a decision it may be necessary for models of the new design to be produced or perhaps environmental tests might be undertaken.

The team is now in a position to move towards the final stage of the study and formulate its recommendations for the REPORT stage. In the report prepared by the Value Engineer the study is reviewed and presented to include the potential savings for the Post Office forecast by the VA team recommendations.

When the team has agreed its report it is sent to the heads of those divisions represented on the team for approval. The team then usually disbands.

Despite all this work, however, no actual savings have been made up to this point. So the VA team member now progresses the final stage of IMPLEMENTATION. This involves seeking sponsorship from the operational department as well as co-operating with the development department's engineers who will be involved with the extra work in meeting the recommendations.

On completion of the work the newly analysed product should provide considerable savings for the Post Office, help maintain lower prices to customers and increase export potential as well as providing job satisfaction to all concerned.

Successful organisation and operation of a Value Analysis programme costs money. Even Value Engineering on new products is an additional expense to the design process. But generally a savings return to the Post Office for the cost of the VA studies and necessary support work exceeds a 10 to one ratio.

Value Analysis Division staff are in fact aiming to help in identifying savings each year against an overall target set at £750,000. But, as everyone knows, it is much easier to spend money than to save it. There is no doubt, however, that Value Analysis is playing an important role in helping the Post Office hold its costs down even in these difficult economic times.

The success of a VA exercise depends much on the involvement, enthusiasm and co-operation of those taking part. But the fact that team members are doing a worthwhile job is reflected in the correspondingly successful results.

**Mr C. M. Halliday** is head of a section in Value Analysis Division at Post Office Headquarters responsible for VA studies.



# When the oil men came to town

**A Cameron**

**Continued from page 20**

exchange. Now there are five satellite exchanges and there will shortly be seven, with an eighth to follow.

One of the new satellites was hurriedly set up on a temporary basis using four mobile non-director exchanges: it already has a waiting list. In the meantime, the main exchange building is undergoing a £1 million extension and will eventually become solely a trunk and group switching centre with associated automanual board.

Telex growth has been remarkable, demand rising from 41 connections in 1970–71 to 244 in 1974–75. The telex exchanges at Aberdeen and Inverness became overloaded and although both have been extended, temporary relief for the Aberdeen exchange has had to be sought by connecting new customers in the Peterhead area to Glasgow telex exchange by the use of 12-channel voice frequency systems. Customers have been prepared to accept this out-of-area service rather than wait.

It is one thing to provide on demand facilities such as multi-line PABXs, telex, datel and long distance private circuits to places like Abu Dhabi in a large centre such as Aberdeen. It is, however, quite another matter when the requirement arises at a remote rural exchange with very small switching and junction capacity.

But this is exactly what happened at Nigg, Ross-shire where there was a small UI2 exchange on a remote point of land with four overhead junctions to the manual exchange at Tain 12 miles away. Proposals were made for a large oil platform fabrication yard employing up to 2,000 men. The exchange was completely inadequate in terms of subscribers' equipment, switching capacity and junction outlets to cope.

Calculated risks had to be taken that the project would receive planning permission to go ahead and plans were hurriedly put in hand for a UI3 exchange (the only type immediately available) and the laying of duct for a new junction cable at an initial cost of about £100,000. Fortunately the platform project went ahead and the revenue from Nigg exchange grew from only £478 in the quarter ended November 1971, to £18,500 a quarter now, plus substantial sums for private wires and telex. The UI3 exchange has already been replaced by a SAX.

This development and various associated projects put tremendous strain on Tain manual exchange – housed in two wooden huts and long overdue for conversion to a crossbar group switching centre. The 11-position switchboard was overloaded, there was no room for extension and staff were attracted away to jobs with the oil companies.

An extension of eight positions was installed in the training room in the adjacent GSC building and after some initial trouble with signalling it has given a large measure of relief. But even this did not prove enough and further relief was obtained by the platform fabricators agreeing to rent a number of out-of-area lines on Dingwall exchange giving them STD facilities.

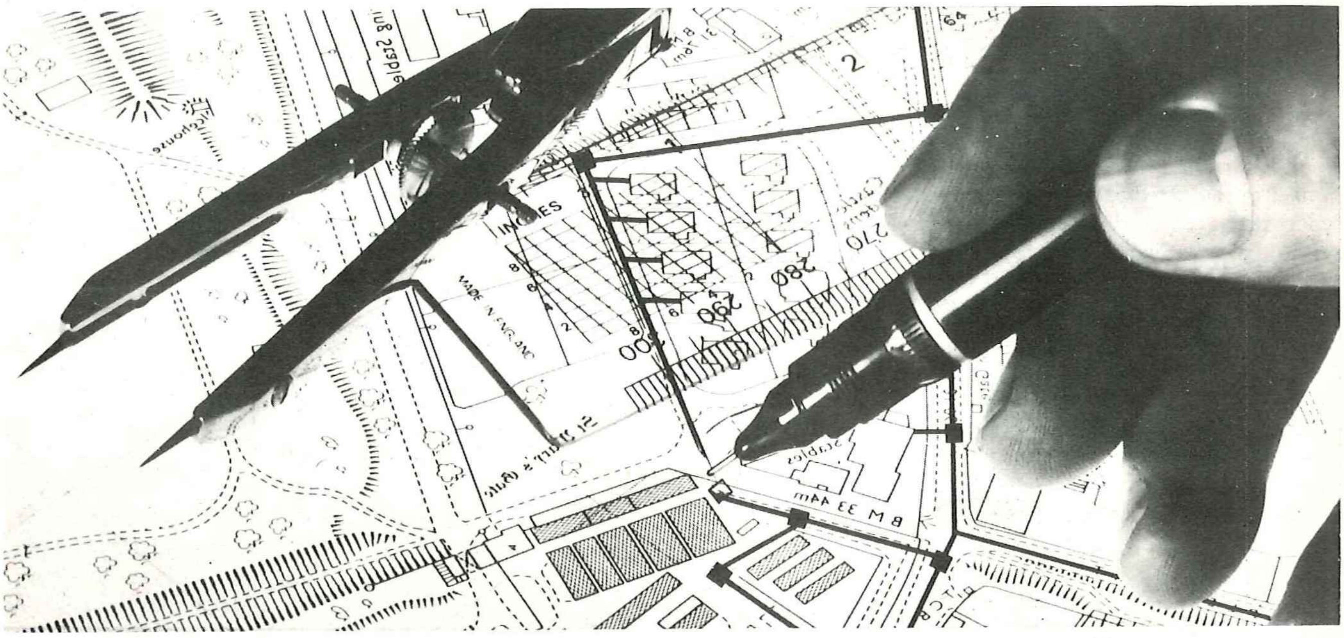
Some more of the load was taken off Tain by installing a mobile tandem exchange at nearby Kildary which diverted a certain amount of local inter-UAX traffic from the manual board. Also, by using a spare charge group facility in the group switching centre at Dingwall, it was possible to give outgoing STD facilities to Kildary subscribers while still using Tain as the charging point.

Operating staffing problems could not be overcome locally and we borrowed operators from many parts of the UK to help out – a process we had to repeat at Lerwick, where girls came up to help from as far away as Penzance.

Pressure on space in the Telephone Area Office has become acute and staff are now housed in five separate buildings in Aberdeen. New office premises, like housing, have become extremely expensive, but a long term lease has now been obtained on a new office development which will enable staff to be concentrated in just two buildings in about 18 months' time.

Altogether, there are now 102 building schemes – most of them for new exchanges – in planning or at various stages of construction. It has been aimed throughout to give priority to business customers generally and to energy-related firms in particular but every effort has also been made to satisfy residential customers.

**Mr A. Cameron** is General Manager of the Aberdeen and North of Scotland Telephone Area.



# MISCELLANY


**A date to remember ... the Mayor of Abingdon, Oxon, makes the final call on the town's old telephone exchange during a ceremony to mark the closing of England's last manual exchange. (See page 1). Abingdon is now served by an automatic crossbar exchange.**

## Spanish link

The opening of Britain's second submarine telephone cable link with Spain has increased the number of direct telephone cable circuits between the two countries from 480 to nearly 2,000. The new cable, jointly owned by the Post Office and Compania Telefonica Nacional de Espana, runs 465 nautical miles from the Lizard peninsula in Cornwall to Sopelana near Bilbao, and can carry up to 1,380 calls simultaneously.

In addition to UK-Spain traffic, the cable will carry calls between the UK and Italy, and possibly between the UK and Portugal and Morocco. It is also likely to carry calls between Spain and Belgium, Denmark, Eire, Finland, the Netherlands, Norway and Sweden.

## Connections grow

Britain's telephone connections have passed the $12\frac{3}{4}$ million mark. Post Office figures show that in the year ended 30 April the number of exchange lines in service rose to 12,756,894 – an increase of 6.7 per cent over the figure at the same time last year.

And the public teleprinter service operated by the Post Office grew by more than 10 per cent in the year ended 31 May. The number of working telex lines now exceeds 55,000.

## Appointments

**Mr C. A. P. Foxell** is to be the new Deputy Director of Research at the Post Office Research Centre, Martlesham Heath, Suffolk. At present Managing Director of GEC Semiconductors Ltd, Mr Foxell takes over his new post on 1 September in succession to Dr J. R. Tillman, who is retiring.

**Mr J. S. Whyte,** Director of Operational Programming at Telecommunications Headquarters, has been appointed Director of Purchasing and Supply.

**Mr K. A. Hannant,** Director of International and Maritime Telecommunications Region, has taken over Mr Whyte's former post.

**Mr D. Wray,** Deputy Director External Telecommunications (Planning), has succeeded Mr Hannant as Director of International and Maritime Telecommunications Region.

## New TXE4 version

Following the successful completion of studies aimed at using integrated circuits instead of separate components in the TXE4 electronic exchange system, the Post Office placed a £6 million contract with Standard Telephones & Cables Ltd to carry this line of development into the system.

The new version, called TXE4A, is expected to provide a significant reduction in production costs. The effect will be still further to increase the economic and other benefits of the Post Office programme to modernise Britain's local telephone exchanges.

As part of the development contract, two models of TXE4A will be made for evaluation and testing. The first will be installed in STC's switchgear factory at New Southgate, London, and the second will be a pre-production model provided for detailed Post Office study. Meanwhile, the first production TXE4 exchange is scheduled to open in Birmingham next year.

## Computing success

The Post Office's National Data Processing Service is to operate a new system for calculating the international telecommunications accounts of 25 Commonwealth countries. In the cost-sharing scheme, known as the Commonwealth Telecommunications Financial Arrangements (CTFA), settlements are based on the use of international links owned by the partner countries. Provisional and final settlements are derived by using a computing system.

The existing CTFA system has been operated by NDPS since April 1973, using a Burroughs B5500 computer. Under the new contract, gained in the face of strong competition, the system will be run on the Post Office's IBM 370/168 processor which came into service last year. NDPS has also secured a contract to convert the existing system to enable it to be run on the IBM machine.

## Series completed

The last in the series of INTELSAT IV communications satellites for the International Telecommunications Satellite Organisation was expected to reach its operational position 22,300 miles over the Indian Ocean in mid-July. It follows six others – one already on station over the Indian Ocean, three over the Atlantic and two over the Pacific. A new generation of satellites, called INTELSAT IVA, is now under construction.

## Telex guide goes metric

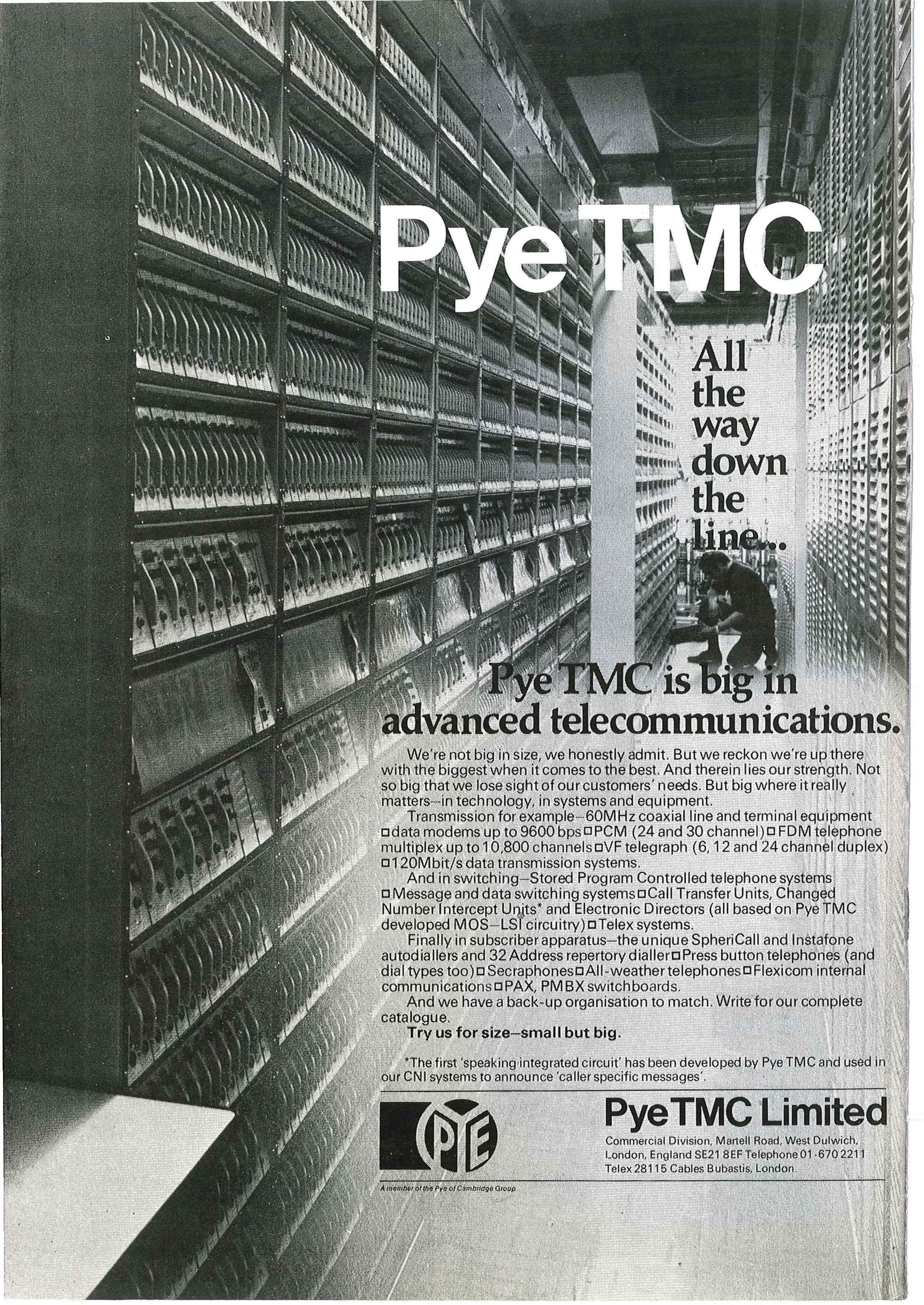
The next edition of the telex directory, due in October, will be in the international metric-based paper size A4 – the new size for telephone directories from next year. This will enable the Post Office to cut its printing costs by producing the telex directory in one volume again. The present directory has smaller pages and was split into two volumes in 1974.

## Contracts

**GEC Telecommunications Ltd** – More than £2 million-worth of private telephone exchange equipment. It includes private automatic branch exchanges for installation in Government Offices, selectors and other equipment for PABX switching, and equipment to interconnect private exchanges.

**Standard Telephones & Cables Ltd** – £2 million for data modems. The equipment is for operation at 2,400 bit/s and will be used for the Post Office Datel 2400 service.

**Marconi Communication Systems Ltd** – £1.9 million-worth of pulse code modulation equipment. The contract includes a quantity of equipment designed to protect PCM line systems from high induced voltages, such as those caused by lightning. A further contract has also been awarded for nine Spector telegraph error correcting systems for use in the communications network which links the Post Office radio stations at Wick, in Caithness, and Norwick in the Shetlands, with North Sea pipe-laying barges.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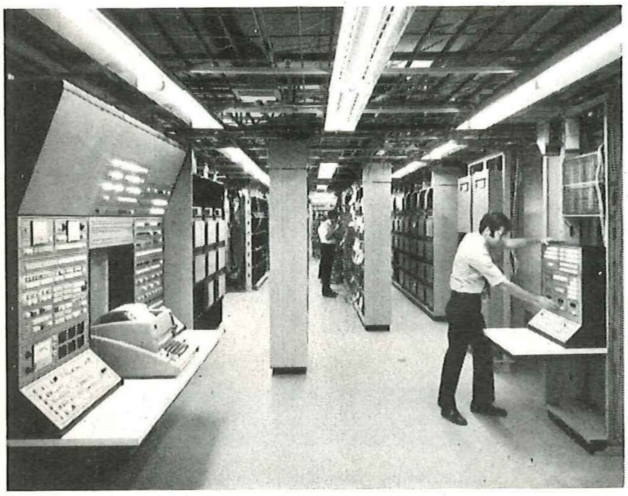

The No. 1 EAX stored-program controlled electronic switching system has been designed for large local and long distance exchanges.

Here are some of the telephone administrations that are using or have ordered this modern high-speed system.

General Telephone Company
 of Pennsylvania
General Telephone Company
 of the Southeast
General Telephone Company
 of the Southwest
Hawaiian Telephone Company
Highland (New York) Telephone Company
Jamestown (New York)
 Telephone Corporation
 (Mid-Continent Telephone Corporation)
Lincoln (Nebraska) Telephone &
 Telegraph Company
Lorain (Ohio) Telephone Company
Mankato (Minnesota) Citizens
 Telephone Company
Mid-Penn Telephone Co.
 (Mid-Continent Telephone Corporation)
Midstate (New York) Telephone Co.
 (Mid-Continent Telephone Corporation)
Northern States (North Dakota)
 Power Co.
Princeton (Indiana) Telephone Co.
Roseville (California) Telephone Co.
Sugar Land (Texas) Telephone Co.
Western California Telephone Co.

In addition to these administrations, 35 also have in service or on order the C-1 EAX stored-program controlled system designed for small-to-medium size telephone exchanges.

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